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EDITORIAL ANNOUNCEMENT.

Mr. Wallace's Papers

THE country is fast reaching a clear recognition of the fact that the Panama Canal is a great problem—great in its promise and opportunities, but great also in its requirements and responsibilities. It is too great to be solved by anything but the best of engineering genius and administrative policy, and it is of course far too great to be even outlined in a single paper. For this reason the following article bears the character of an introduction, and indicates the lines which Mr. Wallace will trace out in succeeding numbers.

No man is better equipped than he to discuss the work from the viewpoint of practical construction. His residence on the Isthmus, in close contact with the details of organization, both in the field and in Washington, have placed him in an attitude towards the undertaking different from that of any other engineer connected with it since the French *régime*. He has had to meet "all the conditions there are" in attempting to place the Canal on the footing of a successful engineering construction. The knowledge of these conditions is essential to a correct understanding of what the country has undertaken to do, and what it must do; but the knowledge has never been presented heretofore. The ENGINEERING MAGAZINE, in this and the immediately following numbers, will place at the disposal of the profession the substance of Mr. Wallace's year of study of the Panama Canal question.

The first section, here presented, as already stated, is wholly introductory. Running rapidly over the preceding history of the project, the author comes down to the appearance of the United States on the Isthmus, under the auspices of the first Commission. The dream of the ages has become the problem of today. How shall we approach it? Surely, without bias or prejudice of any sort—as open-minded and impartial as the traditional "Man from Mars." To such an impersonal

EDITORIAL ANNOUNCEMENT

Continued— *Mr. Wallace's Papers*

judge, the knowledge necessary to decide the case would include, in Mr. Wallace's view, the purpose of the United States in promoting trans-isthmian traffic; the evidence as to the best mode—whether railway, ship-railway, or ship-canal; if the last-named, what route presents the greatest net advantage; finally—purpose, medium, and location being decided—what are the arguments which establish the desirability of settling upon certain engineering details? How shall the field work be organized? And (possibly most important now of all) by what method, direct or indirect, shall our Government carry on the construction? This, Mr. Wallace indicates, is the conception under which he has studied the question, and the spirit animating him is very clearly indicated in the following extract from the paper here presented:

> "The writer desires, through the pages of this magazine, to give the engineering profession, and the country at large, such information as he thinks will, in some measure, be useful in assisting those interested to arrive at a more accurate understanding of the subject.
>
> "It will be his endeavor to consider the subject from the standpoint of a disinterested and unprejudiced investigator, without fear or favor of those who may be selfishly interested politically, financially, or otherwise, eliminating all motives of malice or self-interest. Although it is not to be expected that his views will meet the approval of all, he at least desires that his loyalty to his country and the sincerity of his motives will be appreciated."

The second paper, next month, will take up concretely the work done during the past year, including the organization up to the time Mr. Wallace left the Isthmus, and show clearly what has been actually accomplished, under the attendant conditions. Then will follow a brief description of the various plans proposed, with comment pro and con, and the conclusion will deal with the administrative and executive features of the work, with Governmental methods and their effects as displayed in the results accomplished on the Isthmus, ending with Mr. Wallace's judgment of the situation as he has found it through practical experience.

THE
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"THE WORLD IS ITS FIELD"

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SOME ECONOMIC ASPECTS OF ELECTRIC-POWER DISTRIBUTION.

By Dr. Louis Bell.

While Dr. Bell, in the conclusion of his article, rapidly summarizes the accepted standards of electrical and mechanical practice in power transmission and distribution, his discussion is addressed primarily to a much broader aspect of the subject. This is the influence which electric-power distribution is already exercising and will continue increasingly to exercise in re-distributing industry and population. It promises to be a most powerful factor in opposition to the centralizing tendency of steam or water, as direct motive powers for manufacturing establishments, and so to annul many of the worst evils of the factory system and the social conditions accompanying it. The vast and beneficent effect which this may have on material civilization is traced by Dr. Bell, ably and with real inspiration.—THE EDITORS.

MUCH of the complicated mechanism which we are pleased to call modern civilization has for its purpose the survival of the unfittest and the subversion of natural laws. Instead of punishing criminals, we spin fine-drawn theories about them and turn them loose to be a drag upon the progress of decent society. Instead of segregating degenerates in suitable asylums, we form societies for the study of their literary and artistic works and pay two dollars per seat to hear their mephitic plays. We treat economic laws with even more contempt than civil and criminal laws. Professors of the Dismal Science sometimes speak of the law of supply and demand as bearing at least some remote relation to actual human needs, while in reality the basis of many movements in modern industry is the substitution of an artificial law for the natural one. If vested interests have acquired an unprofitable railroad, which upon a sound commercial basis should not have been built prior to 1950, there is at once a cry for such a "readjustment" of rates as shall charge up the loss to communities along lines which were more wisely planned. Fortunately, civilization brings good along with the evil; and while there is terrible loss of energy in the artificial methods employed, there is still progress, not so much perhaps as the world flatters itself in thinking, but progress nevertheless.

In the last resort, the substance of civilization is human development—all the rest is accidence. The Greeks had no knowledge of steamships, railroads, electric lights, telegraphs, or automobiles—they would have proffered hemlock to the man who had tried to start a telephone exchange; and yet no people ever reached a higher human plane of thought and action. Likewise our little Japanese friends, cheerfully hailed as barbarians barely fifty years ago, had in reality risen to a mental and spiritual height that enabled them in thirty years to grasp the material advances of well-nigh thirty centuries.

The lesson to be learned, then, is to value the achievements of modern science and industry not upon their proceeds in dollars and cents next week or next year, but by their effect upon the growth of humankind and the evolution of a sounder society. In discussing, then, the effects of a particular branch of technical progress, it should be considered in this broader aspect and not merely from the so-called "economic" standpoint which is concerned exclusively with the balance sheet. To come down to the concrete, in the larger view of things it is of little consequence that John Doe should contract for electric power at an annual saving of $10,000, if (as in nine cases out of ten) he will merely put the money into his pocket; the real importance of the gain is measured by the number of people who are benefited by it. If, on the other hand, the contract enables John Doe to put out his goods at a lower price, or to reduce the hours of labor, or to do anything else to the advantage of his fellow man as well as himself, that contract is of direct value to the community. On the contrary, if a similar contract enables Richard Roe to start an industry where none was before, to open a new bit of territory to human activity, the community is at once directly the gainer and electric power is no longer an instrument of private gain, but of general welfare.

Of course, one may say that all private gain goes ultimately to the increase of industry; but unhappily the self-constituted redistributor of wealth is not always a philanthropist in the proper sense of the term, and vague and indirect methods are usually inefficient ones. The special topic of interest here is the direct usefulness of electric power in the generalization of human activity, rather than its possible indirect value in enabling John Doe's heirs to assist in developing the French automobile industry.

The distribution of manufactures in our own or any other country would be a most curious and interesting subject of study. The first thing to stand out conspicuously in the investigation would be the gradual tendency toward concentration in the larger cities, and the gradual recession of manufactures outside them. Certain sections of the country are full of decaying communities, once active, but from which the chief industries have been withdrawn. If investigation disclosed the fact that certain centers of manufacture had become such through the possession of pre-eminent natural advantages, such a condition would be easily explained; but in fact, natural advantages have comparatively little to do with the matter. It is common enough to find large manufacturing plants of a particular kind concentrated in a place that is only moderately good as a working point. Some one shrewdly-managed factory has made a success there, and has gathered others about it, until by sheer force of output and by combination of interests they have frozen out the scattered factories with small capital. Taking into account also the steady tendency of population to move toward the cities for various causes, the outlook for local enterprises seems far from good. In fact, the situation is fraught with the gravest dangers to the community at large. A country consisting mainly of large cities with merely incidental rural population has taken a long step toward final disintegration. Moreover, even if actual disintegration is not imminent, there exists the curious and anomalous condition of a community in which the transportation and distribution of commodities is the predominant element—in which producer and consumer stand at the ends of a long chain of intermediaries. It is bad enough in this respect, even at present, but every step toward further concentration of industry and population makes it worse. No country in which the productive forces are steadily being subordinated to an intricate (and, upon the whole, wasteful) mechanism of distribution can long remain prosperous.

It is the recognition of this general principle that is the basis of the present agitation for regulation of railway rates and of similar movements.

Starting with the condition that wide distribution of industries is desirable in order to render more simple and efficient the mechanism of commerce, there are two prominent factors in the problem at hand. The first is improvement in the organization of transportation so that needless work can be in part eliminated. The second is such an equalization of the industrial conditions that bear upon manufacture as shall minimize the legitimate need for transportation. For economical manufacturing, one must have moderate costs of raw material, labor, and power. The two former items are strongly affected by transportation conditions, as is also the last-named when its source is fuel.

The importance of electric-power distribution from this standpoint is already great and will become greater. If one takes a map showing the distribution of coal in the United States, it is at once apparent that by far the greater part of the territory either has no fuel at all, or little, and that of poor quality. Wood has been practically eliminated from the question by the rapacious wastefulness of the last quarter-century. Hence as regards the country at large there is a heavy transportation change on power. Within the past ten years we have learned to utilize the water powers of the country (which, by the way, are as a whole in the regions having least fuel) and cheap electric power has already done much to open new fields to manufacture, especially in the South which is the natural field for cotton manufacture. In one particular the present working of hydraulic power is very faulty, and to this defect I wish to direct especial attention. In spite of the great growth of electric-power transmission, its effect on the consumption of fuel has thus far been very small, owing to the fact that the great mass of hydraulic power, which is in small units, has practically not been touched at all.

Of our total water power, probably four-fifths is in falls below 1,000 horse power in capacity, and at the present time money can rarely be found for the development of small enterprises of this kind. Bankers as a rule have not the slightest interest in these small permanent investments. They will lend moderate amounts upon quick assets, but frankly say—and with a showing of truth—that they can handle a bond issue of a million dollars with no more labor than one of a hundred thousand, and with ten times the profit.

To my personal knowledge, there are scores of water powers in New England able to furnish preposterously cheap power for small industries by transmissions of trivial length, but they are cases for private investment and not for "financing." By utilizing such privileges it will often be possible for small industries to obtain power at less than half the cost paid by their larger competitors. The present adverse factors are mainly due to transportation. Putting aside the instances of deliberate discrimination in rates—which are altogether too common —there is a strong general tendency toward punishing the industries in small places situated on non-competitive lines. At this point the electric railway is beginning to come in as an ameliorating influence, and if its development is allowed to go on unimpeded, much good will be done. Every electric railway network means a readier market for every point touched, and when light freight haulage becomes more general the influence will be very strongly felt, unless the non-urban communities are foolish enough to allow the electric systems to be captured by the steam roads which now hold the field. The small hydraulic powers already referred to are well able to furnish cheap motive power for transportation, if given the chance, and thus to make the regions served more self-supporting and self-reliant.

The effect of cheap electric power in encouraging and conserving small industries has already been well demonstrated, particularly abroad. In several regions on the Continent its introduction has preserved the industrial autonomy of large groups of villages threatened with extinction by the very forces more conspicuously active in the United States. Since the existence of a small industrial center means increased prosperity in all the region about it, the value of such a policy to the community is all the more evident.

Bearing in mind the cost of transportation, the manufactures which can profitably be carried on in small places having cheap power available are especially those in which the value of the finished product is due mainly to the expenditure of power and labor, in particular highly skilled labor. Besides these, there are also some industries in which the raw material can be obtained locally. It is sometimes popularly supposed that skilled labor is not easily obtained outside of considerable cities. It is perfectly true that in certain lines skilful workmen are now mostly to be found in large industrial centers, but on the other hand they are the easiest class to get away from these centers when good employment offers. It is the ordinary "lumper" who is most gregarious and who is most unhappy when withdrawn from the associations of the city. And in fact, in small places where the workmen are stable and responsible members of the community the difficulties of the labor situation are at a minmum.

To come to concrete figures, there are today many unutilized powers ranging from 200 to 500 horse power that can be acquired and developed, including an electric transmission of moderate length, for about $100 per horse power delivered. They are cheap simply because they are on rather small streams easily controlled in places where at present there is small demand for power. A factory wishing power can thus obtain it, as the investment cost shows, at a very moderate rate and in the majority of instances can get the few hours of hydraulic storage necessary for utilizing enough of the energy for lighting to offset no inconsiderable part of the expenses. There are now not a few small industries clustered about little water powers, but electric transmission has yet to play its part in bringing isolated waterfalls into use where there are existing facilities for transportation. It is almost an untouched field and one of great promise.

As an extension of the same idea one should consider the new phase of power transmission which unites into net works the available powers of a considerable region. This is the basic principle of some very considerable systems and applies with equal force to smaller ones. Given three or four small powers within a few miles of one another, and when united they can not only furnish their aggregate power at one or several points but are generally available for an amount considerably greater than the sum of their nominal powers. It often happens that one of the lot has available storage greater than would be advisable to utilize independently, but which can be used very economically to help out the entire group. I call to mind one case with several plants on the same stream where the storage of the upper one can be conveniently used in all those below, the time of flow between consecutive stations being sufficient to equalize the output very neatly. Moreover, when several plants are united in a network, the need for duplicate lines is diminished since most points of the network are fed from at least two directions.

Carrying out this principle it is quite feasible to group and utilize several powers, individually of modest size, so as to put electric power into many places where it will be profitable to use it; into every conveniently situated village in a county for the upbuilding of local industries. That which is already done profitably over an area of many thousand square miles can certainly be made highly successful over a few hundred square miles. This work with small powers is relatively very easy, for the distances of transmission are generally very moderate so that no problems of extreme high voltage are involved; the developments of the hydraulic side are usually easy, since the volume of water to be controlled is small, and simple methods can be employed throughout. It is now common practice to run several transmission plants in multiple, so that nothing is to be feared on the operative side of the work. The sole difficulty is the financial one, arising from the small amount of securities involved and a certain disinclination to consider country affairs seriously. The work is most emphatically one most profitably to be undertaken by local interests, interested directly in earning power rather than promotion.

As power propositions are generally financed, the funded debt is expected to cover the whole expenditure, including profits to those who handle the bonds, the entire stock issue being *aqua pura.* Under these conditions the absence of large stock dividends is not evidence of poor business. On the cash actually put in, a well planned power plant, even on a small scale, will generally pay a handsome rate of interest after setting aside a liberal reserve for maintaining the value of the property.

In caring for small industries and developing local resources, Continental Europe is far ahead of the United States. In France, Germany, and Switzerland, there has been a keen interest in preserving manufactures against the inroads of centralization, and a good many electric plants, both large and small, have had this aim in view. The task is rendered easier by close Governmental control of transportation. In America, on the contrary, the tendency toward industrial centralization is at present very strong, and almost wholly uncontrolled. Each census shows worse conditions in this respect, without compensating advantages. It is small glory to have rapidly growing cities fed by depletion of the rest of the country, when at the same time economic waste is increased.

The practical problem to be solved is to make the non-urban regions industrially more useful; and as already pointed out, electric-power distribution and communication gives at least one efficient decentralizing agency. In a concrete case things would work out somewhat as follows:—

A factory starts up in a small town with transportation facilities now reasonably good. With some aid from local interests, it takes up and improves a neglected water power a few miles away; and, not needing the whole output, sells what it can for power and light, thus obtaining its own power at a very low figure. It brings in workmen, not as waifs, but as permanent residents, casting their lot definitely with the community. Presently, ability to get cheap motive power starts someone else at working a small shop; a few more workmen come, business in general begins to feel the effects of the movement, and before long another water-power is pressed into service and tied in with the first, picking up another village on the way with a casual shop and a little lighting.

By this time there has been influx of workmen enough to encourage starting an extra store or two; and then another factory, scenting cheap power, comes along and settles down to business. The united water-powers are pretty well loaded, but then the community is now thoroughly interested; some enterprising individuals pick up a third power ten or a dozen miles off, develop it, and add it to the others, catching an incidental village or two on the way. Each added community adds a few shops, and before long it is time for a little electric road connecting all with the railway. A little telephone exchange starts up and gets connected with the long-distance lines, and within a few years the whole region, covered by the electric net work, takes on an air of new prosperity; the population increases, the farms find a home market, and instead of a decaying backwoods community with one lonely general store, a tumble-down church, and a cider-mill, we have a lively little group of towns, each hustling to get ahead of the others, in close touch with the nearer cities, and a part of the industrial world. There are today little towns manufacturing specialties that are known everywhere, and with decent utilization of natural resources to give cheap power, their number might be increased tenfold. And the modest prosperity thus acquired is stable to a far greater degree than that which depends upon huge urban aggregations of manufacture. The little factory does not shut down because a prominent broker has been speculating too freely, or because a foreman has employed a non-union scrub-woman.

Technically, the task of organizing a power network for such uses is very straightforward indeed. It simply means following out intelligently principles already familiar. The transmission and distribution of the power is done generally by ordinary polyphase methods, which may perhaps be supplemented more or less by single-phase circuits for small powers. Abroad, some few plants have tried continuous-current distribution with series motors, but the high motor voltages are objectionable on the score of safety. The most interesting feature of engineering small plants lies in the tactful use of water storage. For example, take a power giving 300 horse power off the shaft of the wheel. The normal generator in such a case would be of about 200-kilowatts capacity. This could easily be used up in power and could be put to use in lighting only after the period when lap-load occurs. But flash boards and two or three acres of storage at a working head of, say, 25 feet would put another hundred kilowatts into service for the couple of hours necessary to carry the load over the peak, so that the plant could earn moderately at least for 24 hours per day at no great added expense. A few additional acres will sometimes work wonders. I call to mind, right in New England, several instances in which, at a low figure, enough storage is attainable to carry a plant over the entire dry summer season. The trouble heretofore in the electrical-power business has been that men were hunting for big streams with several-thousand horse power available for long transmissions to the larger cities, and altogether overlooked scores of available small powers, relatively much cheaper to develop and with far nearer markets.

The number of big transmissions is necessarily limited—there is but one Niagara, but one great cataract on the Zambesi. Though the former may be loaded to its utmost, and the latter may turn every wheel from the Equator to the Cape, the bulk of the world's power will still remain in small units. The world's coal supply, while in the aggregate probably much larger than is generally supposed, is being drawn upon at a rate that implies, merely from increased difficulties of mining and lengthened transportation, a steady increase in price; but the rains will still fall and the rivers flow when our coal has to come from Thibet or Matebele Land.

Long before that time, the industrial salvation of a country will be the utilization of its smaller powers. And every beginning made now will help to put off the day when the earth will have to call on the skies for heat as well as motive power, or shift its activities nearer the Tropics. Meanwhile the prosperity of our own and other countries depends upon opening wider areas to human activity, instead of still further confining it to great centers of population.

MODERN MACHINERY AND THE PANAMA CANAL.

By A. W. Robinson.

The first part of Mr. Robinson's very valuable study of the Panama Canal problem occupies the following pages. The concluding portion—a summary of the "Available Types of Dredging Plant"—will appear next month.—THE EDITORS.

IT is confidently expected that the work of excavating the Panama Canal can now be performed with less expenditure of time and money than would have been possible a few years ago. Let us examine the question to see what similar works did actually cost, and also see what tools are now available for the work, and how much better—if any—they are than their predecessors.

For previous examples, we will consider the Suez, Manchester, North Sea, Chicago Drainage, and St. Lawrence canals, and also look a little at other large works involving excavation, as railroad building and iron-ore mining. All these works are of course widely different from one another, and still more different from the Panama Canal as to conditions, and therefore direct conclusions that would apply to the great canal now contemplated cannot be drawn from them without ample allowance for such differences.

I will not attempt in this article to settle off-hand the great problems of the design of the canal that are now being considered. These are questions that involve the most complete exploration and study, and after all the data are got together, the most careful analysis of a trained judicial mind coupled with the highest engineering skill. The general public, and it is to be regretted some engineers also, are too apt to crystallize their first impressions into fixed opinions on a too slender basis of fact. Thus at one time the general public had a firm belief in the superiority of the Nicaragua route, and engineers are already arguing the relative merits of a sea-level canal vs. locks before the full data have been secured. Leaving room for honest differences of opinion, it is quite possible, after all the requisite investigations are made, to review the evidence and make an engineering analysis of conditions and requirements, and to arrive at a logical conclusion as to a type and design of canal that will be best. Modern conditions and modern requirements have advanced since the previous schemes were drawn up, and a canal is now demanded that will reasonably fulfil the requirements of the near future, that will be capable of extension and expansion as those requirements grow, and that can be opened for business within a reasonable time and cost.

Among the considerations in favor of the lock system are: (1) shorter time of construction; (2) less cost; (3) better solution of the hydraulic problems, particularly the control of floods. With modern methods of construction and operation, locks are perfectly reliable, and are quickly operated by power, so that the delay to vessels is not great. On the other hand, a canal with locks can never be enlarged. Lock foundations once in, the die is cast. Should traffic require larger accommodation a new canal must be built—or new locks, for which it might be difficult to find a site and increased water supply. If it can be shown that the more quickly built lock canal can be subsequently enlarged into a sea-level canal at a fair proportionate cost without interfering with its operation, this point would be met. No such evidence has yet been adduced.

A lock canal cannot be enlarged in the ordinary sense of the word. The so-called Erie Canal "enlargement" is practically a new canal. The Welland and St. Lawrence canals have been "enlarged" recently from 8- to 14-foot depth. How? By building an entirely new canal in a new location, which is in places several miles distant from the old. In this respect railroad transportation is essentially different from canal transportation. A railroad is capable of improvement and expansion to meet the growing needs of traffic. Built at first in a cheap and temporary way, it can afterwards by improving the road-bed, rolling-stock, and grades, increase its capacity six times or more. A canal, on the other hand, is bound by its lock dimensions and cannot be enlarged by any method short of complete rebuilding. This consideration is an important factor in the competition of canals and railroads for internal transportation, and helps to explain the fact that small canals have relatively decreased in importance and usefulness, and the railroads have increased.

Locks of 100 by 1000 feet have been recommended, but as the operation of such locks would be wasteful for the smaller and more numerous vessels, it is probable that two or more sets of locks of different sizes would be needed. Who can forecast the ships of the future, when their size has doubled in little more than ten years?

With a sea-level canal, the volume of excavation is greatly increased. This increase, however, is almost wholly in the high ground, where healthful conditions prevail, and where the work of excavation, though enormous, can be more adequately accomplished by the modern machinery later to be described than by those of De Lesseps' day. As far as excavation is concerned, it is simply the removal of a known volume of material at a known unit cost as now determined by the experimental plant of the present commission. The hydraulic problems of a sea-level canal are serious, and upon their satisfactory solution the outcome will mainly depend.

Coming now to actual examples, many comparative statements of existing canals have been published, but the following table has been compiled from original sources, and gives the leading facts in condensed form:—

TABLE I.—DATA OF FIVE OF THE LEADING CANALS OF THE WORLD.

	Suez.	North Sea.	Manchester.	Chicago.	St. Lawrence.
Total length, miles	99	61	35	28	73
Depth, feet	26	29½	26	22	14
Width at bottom, feet	72	72	120	110	100
Number of locks.	..	2	5	...	48
Total rise of locks	..	tidal.	71½	...	551
Length of locks.	..	..	600	...	270
Width of locks..	..	..	65	...	45
Total volume of excavation, cubic yards	99,400,000	104,630,000	53,500,000	40,000,000	......
Total cost of canal	$93,000,000	$39,000,000	$65,400,000	$28,411,920	$85,342,000
Cost ÷ number cubic yards ..	93 cents.	37 cents.	$1.22	71 cents.	......
Year of beginning	1859	1887	1887	1892	......
Year of completion	1869	1895	1893	1900	......
Years in building	10	8	6	8	......
Maximum number of men employed	25,000	10,000	17,000	8,000	......

Suez Canal.—In the Suez Canal the physical conditions presented no special difficulty. The material was mainly sand, with some rock in thin strata near Chalouf, and the greatest elevation to be cut through did not exceed 60 feet, and that only for a short distance. The tides are inconsiderable, necessitating no costly controlling works. Labor was abundant, and so cheap that it competed successfully with mechanical methods for much of the work. In the early stages of the work hand labor with wheelbarrows and buckets was largely used, and men even scooped the mud with their hands. The whole of the cuts through the high ground were taken out in this crude way, the rate of wages being 15 cents to 20 cents per day, without board. Concerning this part of the work, Prof. J. E. Nourse states:—*

> "To effect a channel through the 27 miles from Port Said to Kantara, was a work of greater difficulty than that executed at the port. The sulphuric exhalations of the mud, when stirred under the burning sun

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* Maritime Canal of Suez. 1884.

> of Egypt, were almost insupportable; yet not much more sickness was reported to have occurred than in other localities. The lake fishermen threw up the liquid mud with their hands to form a dike, which, under the powerful sun, quickly dried. When something like an opening had been made and water began to flow in, rafts were constructed on which thousands of these men slept under tents made of mats. An excavation of 40,000 metres was effected.
>
> "When the men had scooped out with their hands a passage of sufficient dimensions, dredging machines were introduced and the trench was widened until it reached the dimensions of 330 feet wide and 20 feet deep. The banks on both sides were solid and firm. On these the dredgers with long shoots were subsequently used, which dispensed with the expensive mode of disposing of the débris into hopper barges and then conveying them to sea to be emptied. The first little dredger (carried in sections across the mud) was followed by twenty more, which excavated two ditches 20 or 25 metres in width, leaving the intermediate space to bé excavated by the dredgers with long shoots."

All the dredges were of the endless-chain type, and at first the material was deposited into barges and dumped in the lakes or in the sea. Soon great difficulty was encountered in getting rid of the stuff, and dredges with a long shoot or "couloir" were devised. In these dredges the material was raised to a height of 40 to 44 feet and dumped into a hopper, whence the spoil was carried ashore in a couloir some 220 feet long. This couloir consisted of a trough or spout carried by a skeleton frame or cantilever of wrought iron, the base of which rested on a separate float alongside the dredge. The couloir had a slope shorewards of about 1 in 10, and the discharge was assisted by a stream of water, and by a chain with scrapers attached which was caused to travel down the bottom of the couloir. The buckets of the largest size had a capacity of 14 cubic feet and passed at the rate of 20 per minute. The average output of 22 of these dredges was 36,000 cubic metres (46,800 cubic yards) per month each.

The greatest difficulty was to dispose of the material on the bank satisfactorily, and it is evident that, whatever the length of the couloir, the deposit of mud, sand, and water, must sooner or later reach a point at which some of the material will run back again.

The Suez Canal was undoubtedly a great achievement in its day with the appliances then available, but there is but little in it that furnishes any useful data for meeting the problems of the Panama Canal of today. The conditions are entirely different and vastly more difficult, even with our superior appliances. De Lesseps, confident of victory after the success of his first achievement, boldly attacked the Panama problem—and we all know how he failed, notwithstanding his splendid optimism and indomitable will. These qualities applied to Panama difficulties are precisely the ones that would lead to disaster.

The large dredges at Suez were a great improvement over hand labor and were able to accomplish 50,000 cubic yards per month. A large and powerful hydraulic dredge of today has a capacity ten times as great, or 500,000 cubic yards per month. One large dredge designed by me has, under exceptionally favorable conditions, made an output of 750,000 cubic yards in one month.*

North Sea Canal.—In this canal of recent date, one would expect to find good organization, modern plant, and a generally well carried out scheme. The Germans are scientific and systematic, and in their dredging machinery they are well advanced. In excavators for dry work the standard machine used is the endless-chain type which requires a level track of five rails and a crew of thirty-six men. These machines, of which the Lubeck Company has built such a great number, were largely used for the dry excavation. Here also we first find hydraulic dredges, used with long discharge-pipes, but they were of comparatively small size. Most of the subaqueous dredging was done with endless-chain machines of the ordinary type. The conditions being favorable, climate good, wages low, and the work done in the midst of a country of abundant resources, we find the unit cost low. The canal was opened on the date originally set for it, and no additional grants of money were asked for beyond the original estimate. The estimated cost was as follows:—

TABLE II.—COST OF THE NORTH SEA CANAL.

Ground	$2,500,000
Excavating and dredging	17,500,000
Embankments	2.000,000
Locks and quays	9.000,000
Bridges and ferries	1,750,000
Fortifications	375,000
Canal boats, magazines and shops	375,000
Hydraulic and electric installation	500,000
General expenses and compensations	1,250,000
Contingencies	3.750,000
Total	$39,000,000

The above cost is that given in Table I, and although it is probable that some items exceeded the estimate, I have been unable to find to what extent, or to obtain official figures of the actual cost.

Manchester Ship Canal.—This work was commenced under a contract with T. A. Walker for £5.750.000 ($27.945.000), but in

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* See Engineering News, July 28, 1904

November, 1890, the Canal Company abrogated the contract and undertook to complete the work themselves. Difficulties had arisen over extras and unforeseen conditions, which increased as time went on. The total capital expenditure up to the end of 1890 was £9,047,000 ($43,968,420). The total cost of plant to this date was £943,000 ($4,582,980).

The total cost of the work is stated as follows:—

Table III.—Cost of the Manchester Ship Canal.

Construction work, including plant	$43.068,153
Bridgewater canal	8,661,355
Right of way	5,644,146
Interest	5,047,110
Other expenses	3,044,508
Total	$65,465,272

The total excavation was 53,000,000 cubic yards, of which about 10,000,000 yards was sandstone rock. The plant included 173 locomotives, 97 excavators, and 8 dredges. The majority of the excavators were the Ruston & Proctor "steam navvy," a machine similar in principle to the American type of steam shovel, but differing from it in several particulars, the more important being that the English machine has a short car mounted on four rigid wheels, and a single pair of engines performing all motions by means of clutches. The American machine, on the other hand, has a long car mounted on two flexible trucks, and has three separate engines for the motions of hoisting, swinging, and dipper-feeding. It will readily be seen that the two trucks and eight wheels of the American machine would be more flexible on an uneven temporary track, and on account of less load per wheel would be easier to hold up on soft ground, and would be better adapted for traversing sharp curves. By means of the separate engines, all motions can be performed simultaneously, resulting in great increase of speed. The Ruston & Proctor machines, although slow, were very efficient in results and cost of work done, as the cost of labor was very low. A 2¼-yard machine cost at that date £1,200, and has done as much as 2,000 cubic yards per day of 12 hours in sand, but 600 to 700 cubic yards may be taken as a fair average. The working expenses were low, being stated at 30 shillings ($7.50) per day.

There were also four French excavators, by Boulet of Paris, and three German, by the Lubeck Company. These were chain-bucket machines, requiring a well-laid track of five rails on which to operate, and a total crew of thirty-six men. These machines make an average output of 1,500 cubic yards per day in earth. A good American type of shovel of equal capacity can deal with harder material, can work equally well on a temporary track of two rails thrown on the ground, and requires only two skilled men and six laborers.

The construction work on this canal, including locks, cost $43,068,000. As the excavation was 53,000,000 cubic yards, this is equal to 81 cents per cubic yard. This appears a high cost when it is considered that the conditions of labor, climate, and material were favorable. It is partially accounted for by the fact that about one-fifth of the volume was sandstone rock, and also that the nature of the country necessitated much expense in disposing of the soil. It could not be dumped directly on the bank opposite the cutting, as was done at the Chicago Canal. The cars, locomotives, and excavators were also all light and of small capacity compared with American practice.

Chicago Drainage Canal.—This work is not (for the present at least) a navigation canal, and it is introduced here only as an example of excavation. The unit cost does not compare unfavorably with similar works, especially where it is considered that a large percentage was rock and glacial drift. The unit cost is about double that of the German canal, which would be alone accounted for by the fact that the excavation of the harder material would naturally cost twice as much as the soft material of the North Sea Canal. In addition to this, American labor costs about double that of Germany, which would indicate that the American appliances were more efficient. The spoil from the canal was deposited for the most part on the banks directly opposite the cut, forming two high embankments. In this canal, as at Suez, the excavation is the principal item of cost, the subsidiary works being less in proportion than at Manchester or the North Sea.

The work was carried out by contract under the direction and control of a board of trustees. Numerous small contracts were let, and each contractor followed his own notions as to how the work should be done, no two being alike. Much ingenuity was displayed and an interesting object lesson furnished as to methods and results. It is safe to say that, were such a work to be repeated, the experience gained would enable much better results to be secured. So great and rapid has been the advance in the art of dredge and shovel building, that probably not one of the excavating machines used on this canal would be duplicated from choice today.

St. Lawrence Canals.—The data given for these canals in Table I includes the St. Lawrence Canals, the Welland Canal, and the Sault Ste. Marie Canal, the cost being the total capital expenditure to June 30, 1903. These canals, although in separate lengths, are part of one great system, and have in several instances been enlarged and rebuilt. The total volume of excavation for the whole system is not given, but in Table IV are given data of the Soulanges Canal, one of the more recently completed sections, and which represents a modern and well-equipped work of its size.

Table IV.—Data of Soulanges Canal.

Total length, miles	14
Number of locks	4
Rise of locks, feet	82½
Estimated cost	$4,750,000
Actual total cost	$5,792,066
Total volume of excavation	7,608,319
Cost:—number cubic yards	76 cents.
Year of beginning	1893
Year of completion	1899

In considering the above unit cost it must be remembered that the proportion of subsidiary works, as locks and spillways, was large, and is all included. This canal was executed at ordinary American prices of labor, but machinery and tools cost about 25 per cent. more than in the United States and the climate permitted work for only 7½ months in the year.

In Table V are given in detail the quantities and cost of excavation. This work was all done by contract, and therefore includes every expense and contractor's profit.

Table V.—Quantity and Cost of Excavation and Masonry in Soulanges Canal.

	Quantity, Cu. Yds.	Cost.	Cost per Cu. Yd.
Earth excavation	7,264,457	$1,818,308	$ .25
Rock excavation	343,862	334,926	$ .97
Total excavation	7,608,319	$2,153,234	
Masonry	52,767	626,718	$11.88
Concrete	161,048	491,524	$ 3.05

The River St. Lawrence ship channel is a good example of economical dredging work on a large scale. The total amount dredged to June 30, 1903, is 36,654,600 cubic yards at a total cost of $4,910,155 or an average of 13.4 cents per cubic yard.

Iron Mining and Stripping.—A class of excavation work of sufficient magnitude to be noted here is the opening up of the great iron mines of the Lake Superior district. This work is done exclusively by powerful steam shovels of American type. Many of the great mines are open pits, and the ore is uncovered by stripping off a thickness of material sometimes as great as 100 feet over a large area. On the Biwabik Mine alone, 4,000,000 cubic yards of overburden containing gravel, hardpan, and boulders were stripped off to permit of the further excavation of 5,500,000 tons of ore, all of which was done by steam shovel. On this class of work very heavy and powerful shovels are used. A common size is 3½-cubic-yard dipper upon which the engine pull exerted is 60,000 pounds. Such a shovel has been known to load as much as 6,000 tons of ore in 10 hours under favorable conditions. A good average, however, is 3,000 tons, including the delays incidental to such work. This is equal to, say, 2,000 cubic yards of ordinary earth or clay.

As to cost of this work *:—contracts for removing surface at these mines in the earlier days averaged 40 cents per yard. Now, owing to improved methods, standard-gauge equipment, and greater operations, they are not in excess of 30 cents. Actual costs, including repairs and depreciation, but not including profit, for stripping in fairly favorable locations will run from 15 cents to 18 cents per cubic yard, and in some difficult work have not been in excees of 18.5 to 20 cents. This work is done with cars of about 80,000-pound capacity, hauled by powerful locomotives, and covers all expense of maintenance, shifting track, hauling up-grade out of the pit, dumping, etc. The cost of moving the ore is less than that of the overburden. It is heavier and more compact and homogeneous. The digging of the ore and loading it into cars is one of the least items of cost in the total process, and under ordinary conditions a cent, or a cent and a half, per ton will cover it.

In the thirteen years of development on the Mesabi Iron Range more than 16,000,000 cubic yards of overburden have been taken from its mines, at an approximate expense of between five and six million dollars, and the mines have produced 78,000,000 gross tons.

Reviewing the examples cited, it appears that the North Sea Canal was the most economically executed work of its size, and that for dry excavation under American conditions the Lake Superior iron ranges offer the best example of large operations economically executed in difficult material. The experience and results of other works as set forth in this paper are of great comparative interest, but cannot be taken as a basis of cost at Panama, because the work will be done with different tools and under different conditions. The advance which has been made in mechanical appliances for dredging and excavating since those works were executed is very great, and it is certain that modern machines of large capacity specially designed to suit Panama conditions will go far toward offsetting the disadvantages of those conditions.

(Mr. Robinson's second article, "Available Types of Modern Dredging Plant" will appear next month.)

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* Engineering & Mining Journal, February 9th, 1905.

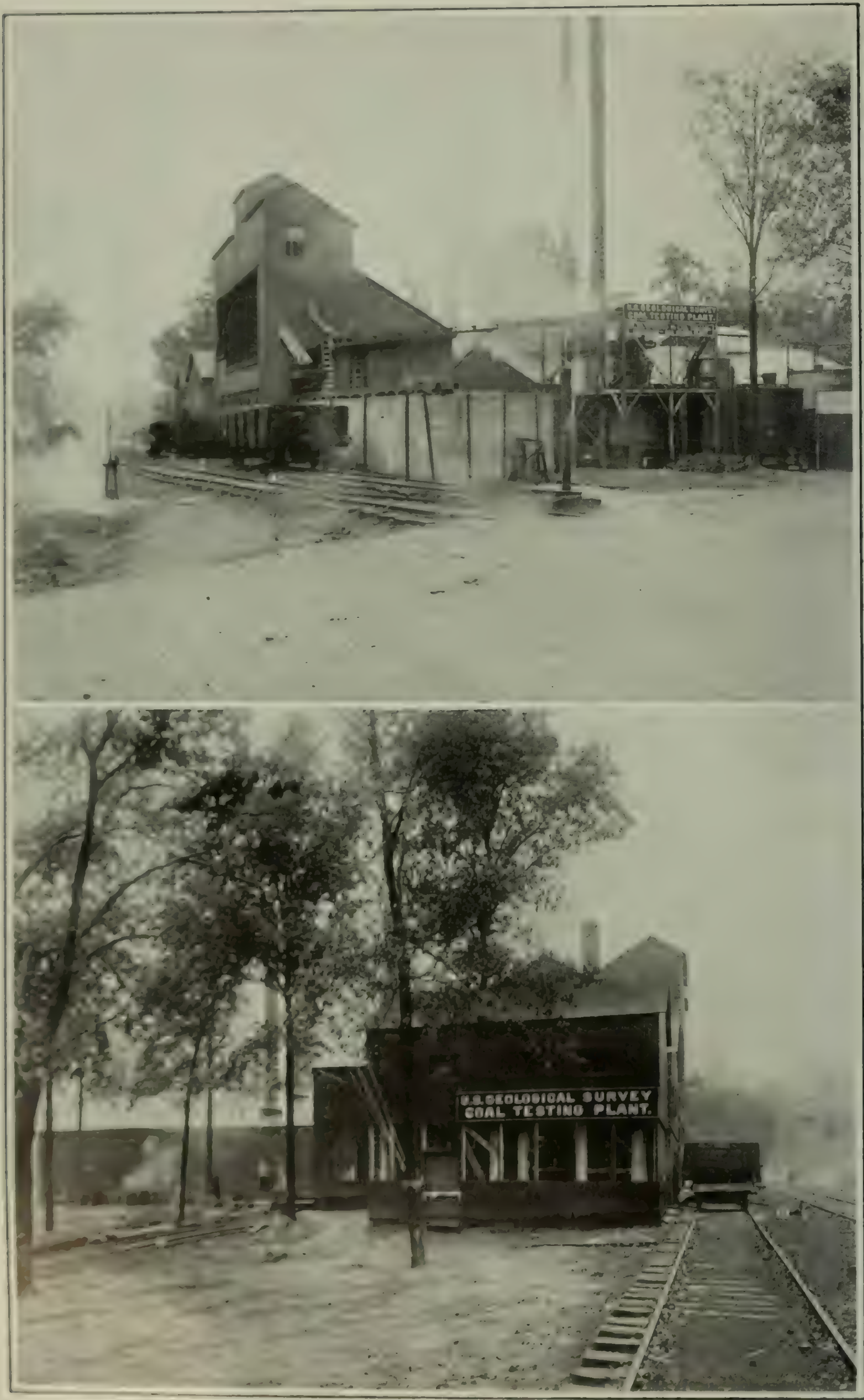
TESTING COALS AND LIGNITES AT THE ST. LOUIS WORLD'S FAIR.

By Edward W. Parker.

The coal-testing work carried out at the St. Louis Exposition—and, it is most earnestly to be hoped, to be continued by further Goverment provision—is probably the most interesting and valuable study of the kind ever undertaken. It is, in brief, a comprehensive, able, and wholly impartial examination of American fuels on a full working scale. We are glad to present herewith the first part of a concise account of the work and the results, prepared by the authority in actual charge of the station. This deals with the general equipment and organization of the plant, the manner of making the tests, and the chemical and steam-raising trials. A second article, next month, will follow with the gas-producing, coking, and briquetting tests and their results, and with the comparative steam-raising and gas-producing values determined in the various fuels.—The Editors.

IN presenting this summary of the results obtained at the Coal-Testing Plant of the United States Geological Survey at the Louisiana Purchase Exposition, a few notes in the way of introduction may not be out of place. In the first place, it should be stated that the suggestion originated with Prof. Joseph A. Holmes, the chief of the Department of Mines and Metallurgy, who believed that the construction and operation of such a plant during the Exposition would be an interesting feature of the Mining Department, and would in addition demonstrate that such lines of investigation carried on by the general Government would be of great value not only to mine operators, but to consumers as well. There is no substance extracted from beneath the earth's surface which appeals so directly to the people, whatever their condition, as coal. Gold itself is no exception, for many thousands of us do not see a piece of gold, especially as coin (its one real use) from one year's end to another, nor appreciate its place in the world's economy. But coal—black, dirty, unattractive coal—appeals directly to nearly every one, high or low.

When, therefore, Prof. Holmes presented his plans to the director of the Geological Survey and asked for his co-operation in the securing of an appropriation for the work, it was immediately obtained. Comparatively little opposition was encountered in securing favorable action from Congress, the members of the appropriations committees of both House and Senate readily appreciating the im-


U.S. GEOLOGICAL SURVEY COAL TESTING PLANT.
U.S. GEOLOGICAL SURVEY COAL TESTING PLANT.

TWO VIEWS OF THE COAL-TESTING PLANT. THE UPPER IS TAKEN LOOKING EAST, AND SHOWS THE WASHERY AND STORAGE BUILDINGS, THE COKE OVENS, AND PRODUCER PLANT. THE LOWER VIEW IS LOOKING WEST.

portant possibilities of such a plan, if it could be carried out without too great an expense.

It might be stated here that Prof. Holmes was fortified by promises from quite a number of manufacturers, to supply free of cost to the Government practically all of the equipment necessary for this pioneer work. Relying upon these assurances, Congress voted two appropriations, each of $30,000, the first being carried on the Urgent Deficiency Bill approved February 18, 1904, the second on the General Deficiency Bill approved April 27, 1904. Each appropriation was made for "analyzing and testing, at the Louisiana Purchase Exposition, the coals and lignites of the United States, to determine the most economical method for their utilization, under the supervision of the director of the U. S. Geological Survey,—*Provided,* that all testing machinery and all coals and lignites to be tested should be furnished to the Government free of charge."

It may be supposed that under this provision, the construction of an ideal testing laboratory was hardly possible, particularly when the short space of time in which to do the work is considered. But the committee in whose hands the work was placed believe that even with full authority for the purchase of equipment, it would not have been possible, in the time allowed, to have assembled and installed a more complete and satisfactory plant than that which was secured through the hearty, and one might say patriotic, co-operation of manufacturers and of the transportation interests. The railroad companies contributed sometimes by billing free, and always by seeing that the utmost dispatch was had in delivery of cars containing machinery and other supplies for the coal-testing plant. The companies contributing equipment, which was entered as exhibits, were as follows:—

Heine Safety Boiler Co., two water-tube boilers each 210 horse-power. Allis-Chalmers Co., one Corliss engine 250-horse-power.

Westinghouse Machine Co., one vertical three-cylinder gas engine 235-brake-horse-power.

Bullock Electric Manufacturing Co., electric generator, belt-connected to Corliss engine.

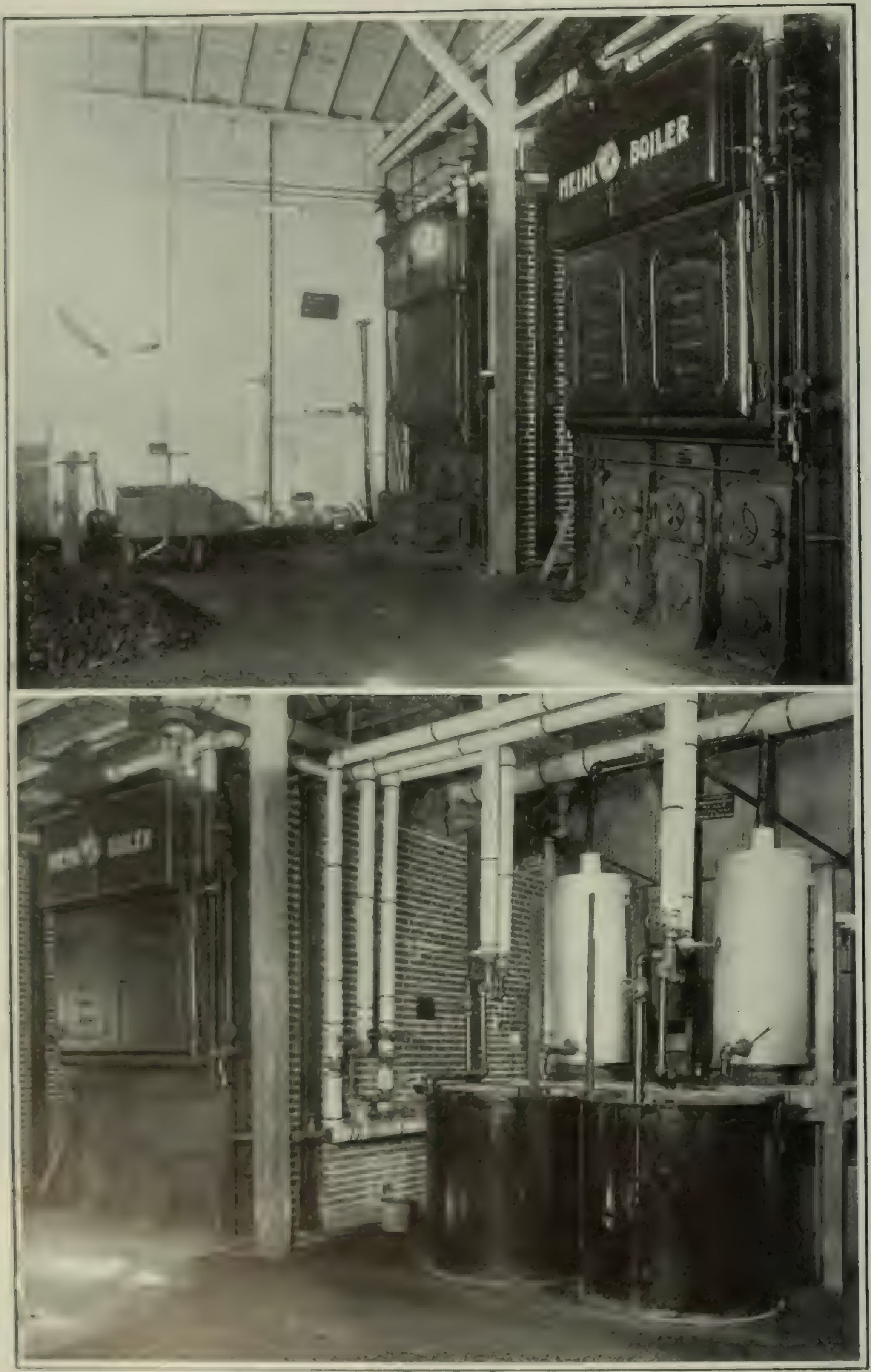
Westinghouse Electric & Manufacturing Co., electric generator, belt-connected to gas engine. Also full complement of motors and appliances used in operating the plant.

R. D. Wood & Co., Philadelphia, Pa., one No. 7 Taylor gas producer, with economizer, scrubber, tar extractor, purifier, and holding tank.

Frost Engine Co., Galesburg, Ills., one fire-tube boiler, 100-horse-power, and one slide-valve engine, 50-horse-power.

C. O. Bartlett & Snow Co., Cleveland, Ohio, rotating dryer.

Wm. Johnson & Sons, Leeds, Eng., briquetting machine.



THE BOILER ROOM. IN THE UPPER PICTURE ARE SEEN THE COAL-WEIGHING CAR AND SCALES, AT THE LEFT; IN THE LOWER ONE ARE SEEN THE WATER-WEIGHING TANKS.

National Compressed Fuel Co., Chicago, Ills., briquetting machine.

Laclede Firebrick Manufacturing Co., St. Louis, Mo., firebrick for coke ovens.

Williams Patent Crusher and Pulverizer Co., St. Louis, Mo., one Williams Crusher.

Robins Conveying Belt Co., New York, a complete outfit of belt-conveying apparatus.

Fairbanks, Morse & Co., scales.

Hohmann & Maurer Manufacturing Co., Rochester, N. Y., thermometers and pressure gauges.

Appliance Manufacturing Co., Chicago, Ills., draft gauges.

Stilwell-Bierce, Smith-Vaile Co., Cincinnati, Ohio, feed-water heater and pumps.

Charles Engelhard, New York, Le Chatelier pyrometers.

Ashcroft Manufacturing Co., New York, and Crosby Steam Gage and Valve Co., Chicago, Ills., engine indicators and attachments.

Steel Mill Packing Co., Detroit, Mich., metallic piston packing.

American Arithmometer Co., St. Louis, Mo., Burroughs adding machine.

American Steel and Wire Co., Chicago, Ills., insulated electric wire.

Waters-Pierce Oil Co., St. Louis, machine and engine oil for lubricating the machinery, and heavy oil and medium oil for binding material in the manufacture of briquettes from bituminous coals and lignites.

Famous Filter Co., St. Louis, Mo., oil filter.

Pittsburg Meter Co., Pittsburg, Pa., gas meters.

Austin Manufacturing Co., Chicago, Ills., dumping car and bucket conveyors.

Henion & Hubbell, Chicago, Ills., centrifugal pump.

Barrett Manufacturing Co., New York, and the Chatfield Manufacturing Co., Cincinnati, coal-tar pitch.

F. W. Braun Co., Los Angeles, Cal., power crusher and automatic sampler for preparing samples for the chemical laboratory.

Buck Stove and Range Co., and Bridge & Beach Manufacturing Co., both of St. Louis, cooking range, for the purpose of testing briquettes for domestic use.

Keuffel & Esser Co., New York, calculating machine.

The committee appointed by the director of the Geological Survey to carry on the work consisted of Prof. J. A. Holmes, M. R. Campbell, and the writer. In the organization of the work it was determined that the investigations must be limited to standardized methods and equipment—that both the letter and the spirit of the law were against the testing of apparatus, or of methods, but were definitely confined to the testing of coals and lignites. So, while recognizing that certain collateral lines of investigation might be well worth trying, and that the results obtained might prove of great value in the settlement of a number of interesting problems, the committee felt compelled to restrict itself to the purposes set forth in the Acts of Congress making the appropriations. For this reason, in the steaming tests, for instance, the furnaces were hand-fired and only natural draft was used. It would have been interesting to have tested many if not all the coals with various automatic or other smoke-preventing devices, but it is well-known that while some of these are most admirably adapted for the combustion of certain coals, they are not as well suited to others and it was not possible to experiment with all of them. The question of burning powdered fuel was also considered, but the method was not adopted for the reason that it is as yet too experimental. So, in the chemical laboratory, much good work in the comparison of certain methods might have been accomplished, but the large number of samples to be analyzed in a comparatively short time made the adoption of accepted methods compulsory, even if the law did not.

BETWEEN THE BOILERS, SHOWING DRAFT GAUGES, AND ORSAT GAS-ANALYSIS APPARATUS IN THE RIGHT FOREGROUND.

In some of the work, which was entirely pioneer, as in the study of briquetting possibilities, some latitude had to be allowed; but this too was limited to the study of binding materials, and the various percentages of mixtures to show, if possible, a method for the practical utilization of now wasted slack or fine coals—this being considered within the intent of "determining the most economical methods for their utilization."

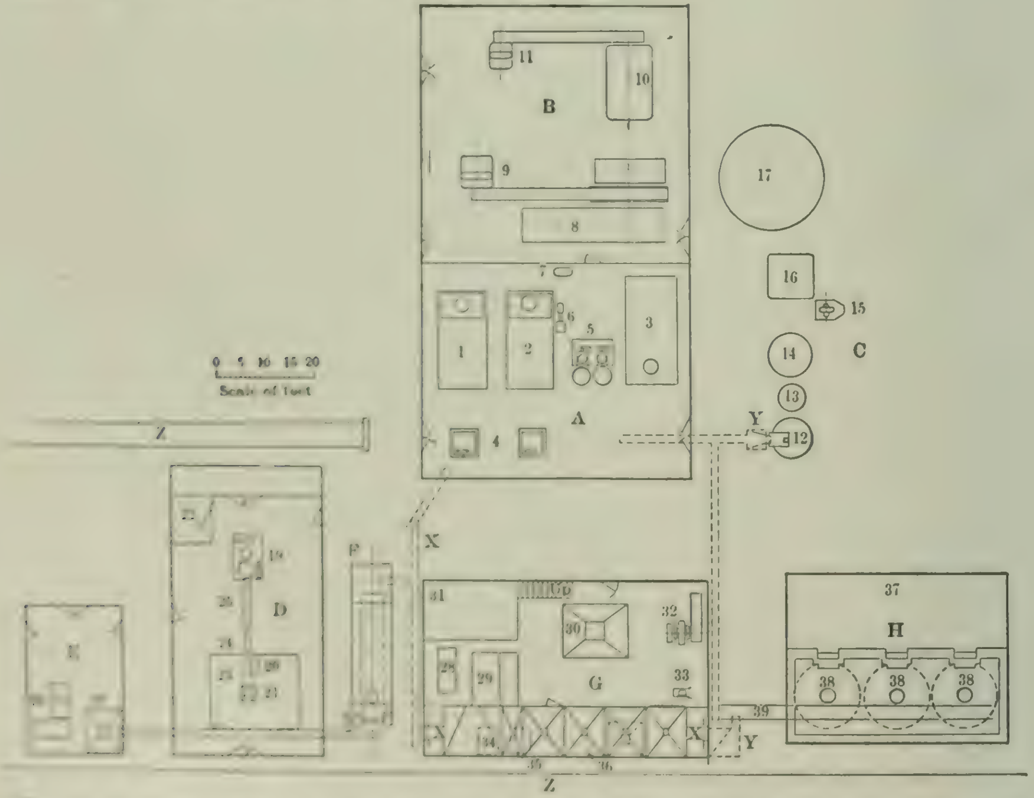
Further, it was recognized that the results of the work would be open to question unless great care was taken in the selection of the coals to be tested. Circulars were addressed to all of the coal operators in the United States from whose mines coal was shipped to market, calling attention to the proposed work, and asking if they desired to ship a carload of their product for testing, under the stipulation, in addition to free delivery, that the coal should be loaded under the personal supervision of one of the Survey's representatives. From the favorable replies received, the country was districted as impartially as possible, so that a representative collection of coals to be tested could be obtained. Mr. Campbell, who has done more work in the coal-mining regions than any other member of the Survey staff, was naturally requested to assume the important responsibility of directing this work. In addition to looking after a great deal of this field work himself, Mr. Campbell had two, and sometimes three, assistants in different parts of the country. In every case, the effort was to secure a fair representation of the colliery's output. If the market of any mine demanded screened coal, screened coal was accepted for test, but the coal was loaded from mine cars taken at random. One car of coal, substituted for the one loaded by the proper agent, remained on the side track at the testing plant untouched, until confiscated by the World's Fair Terminal Railroad for fuel.

When the plant, after a number of exasperating but unavoidable delays, was put into operation early in September, it was prepared to make tests for steam raising, producer-gas making, coke making, briquetting, and for washing, with a chemical laboratory equipped for analytical and calorimetric work. Opportunities for testing the cokes made at the plant were afforded by the "Model Foundry" located a short distance from the coal-testing plant.

The various branches of the investigation were directed by experts who stand in the front ranks of their professions. The steam-raising tests were conducted under the direction of Prof. L. P. Breckenridge, professor of mechanical engineering at the University of Illinois, with Prof. D. T. Randall, of the same institution, as chief assistant. The gas-producer operations were conducted under the supervision of Prof. R. H. Fernald, chief of the department of mechanical engineering of Washington University, St. Louis, assisted by Capt. John A. Laird, consulting engineer of St. Louis;

Prof. N. W. Lord, of the Ohio State University, assisted by Mr. E. E. Somermeier, had charge of the chemical laboratory; the briquetting tests were directed by Dr. Joseph Hyde Pratt, of the University of North Carolina, with Mr. A. A. Steel, of Omaha, Nebr., as chief assistant. The coke-oven operations were conducted by Mr. F. W. Stammler, of Johnstown, Pa., assisted by Mr. B. B. Boyd, of Uniontown, Pa. The coal-washing tests were directed by Mr. John D. Wick, of Chicago.

The plans for the buildings were prepared by, and the construction of the plant was completed under the supervision of, the Roberts & Schaefer Co., engineers, of Chicago, Ills. A full description of the plant has been published in a bulletin issued by the Geological Survey, and need not be repeated here.



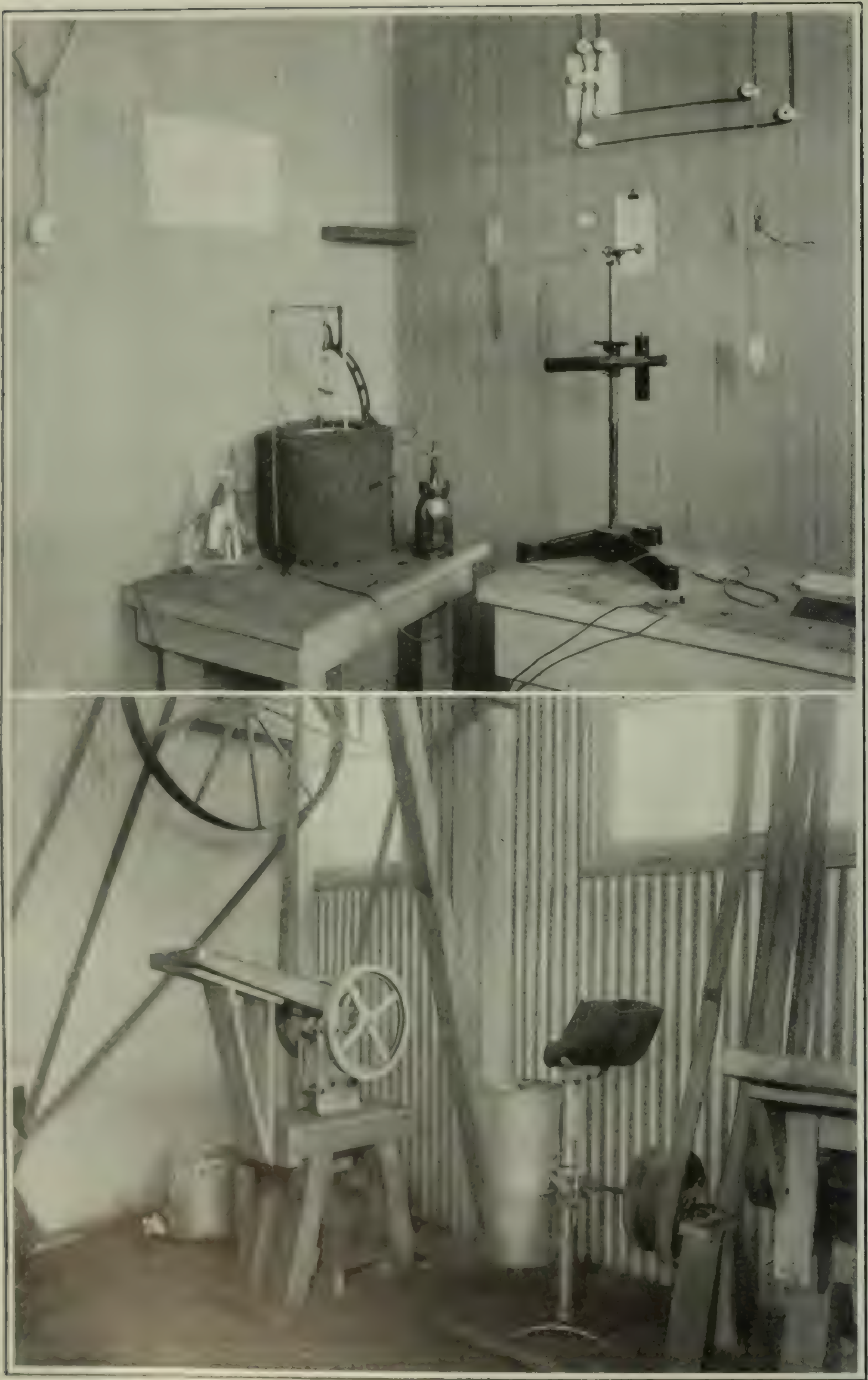
Key to the lettering:—A, Boiler house; 1 and 2, Heine boilers; 3, Frost fire-tube boiler; 4, Fairbanks coal weighing scales; 5, water ditto; 6, feed pump; 7, feed-water heater; B, Engine room; 8, 9, Allis Chalmers-Bullock engine and belted generator; 10, 11, Westinghouse gas engine and belted generator. C, Gas-producer plant; 12, R. D. Wood & Co. producer; 13, economizer; 14, scrubber; 15, tar-extracting fan; 16, purifier; 17, gas holder. D, Briquette plant, Wm. Johnson & Sons, Leeds; 19, briquette machine; 20, pitch cracker; 21, hopper; 22, drier; 23, mixer; 24, exhausting fan; 25, elevator; E, Chisholm, Boyd & White briquette plant; 26, eggette machine; 27, hopper and storage bin; F, Bartlett-Snow dryer. G, washery; 28, Century jig; 29, Link Belt jig; 30, sludge tank; 31, operating platform; 32, steam engine; 33, centrifugal pump; 34, Williams mill; 35, roller crusher; 36, hoppers. H, Coke ovens; 37, wharf; 38, Laclede Firebrick Co. ovens; 39, larry track; X, Robins belt conveyors; Y, storage bins; Z, track sidings.

During the time the testing plant was in operation sixty-six carloads were received. Four of them (all from Pennsylvania) were not shipped according to the prescribed regulations and for excellent reasons. Two were shipped by the Berwind-White Coal Mining Co., and were intended for use in the locomotive tests carried on by the Pennsylvania Railroad Company. They were, however, contributed by the Berwind-White Co. to the testing plant for the purpose of drying out the boiler settings and putting the plant into running order before any testing coal was received. The first two official tests were made on these cars. One car of Connellsville coal was contributed by the H. C. Frick Co., in order that a test of the coke ovens might be made with a recognized standard coal, and the results observed and compared with a carload of Connellsville coke, also contributed by the H. C. Frick Co. These were simply for the purpose of satisfying the committee, and were not to be considered or published as official tests. The fourth car of Pennsylvania coal was anthracite culm, shipped by special request by the Hillside Coal and Iron Company, for testing in the briquetting machines.

The other sixty-two cars were received from sixteen different States, as shown in the classified list on pages 38 and 39.

It should be stated here that it was not deemed necessary to submit every coal to all the different tests. When, for instance, the laboratory determinations showed there was no tendency whatever to coke, the coal was not charged into the ovens. Moreover, as the boiler furnaces were not adapted for burning brown lignites, no steam-raising tests were made on them, the investigations on these being in the line of demonstrating the practicability of briquetting them, and for making producer gas. As will be seen by the reports on the gas-producer tests, it has been clearly shown that a superior quality of producer gas (better than that from bituminous coal) can be made from lignite, and this goes far towards solving, if it does not indeed solve, the problem of utilizing this fuel economically.

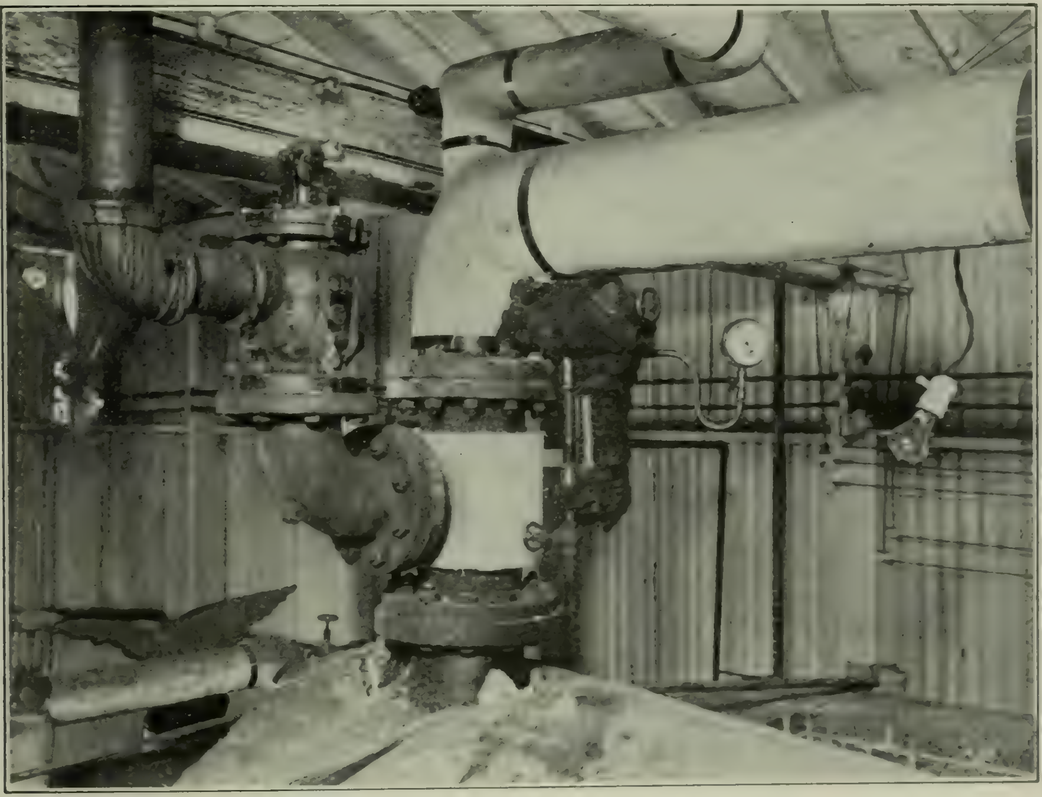
Owing to the fact that only two producer tests could be made in one week, at *any* time, and that when repairs were necessary, even this record could not be maintained, it was not possible to keep this portion of the plant co-ordinate with the boiler or steam-raising operations. Quite a number of gas-producer tests were made after January 1, 1905, the results of which will not be available until the publication of the final report, which is now in preparation. The table of comparisons showing the relative efficiency of the coals when converted into gas and used in an explosive engine, and when burned under boilers, measured by the electrical horse power developed at



PORTIONS OF THE SAMPLING AND TESTING APPARATUS. IN THE LOWER PICTURE, THE PULVERIZING MILL AND AUTOMATIC SAMPLER; IN THE UPPER ONE, THE MAHLER BOMB CALORIMETER, WITH TELESCOPE FOR READING THE THERMOMETER.

the switchboard, forms one of the most interesting features of this article, and demonstrates the importance of continued investigations along these lines.

The Chemical Laboratory.—Equal in importance with the integrity of the carload samples shipped from the mines is recognized the necessity of accurate chemical determinations based upon properly collected laboratory samples. The laboratory was equipped under the direction of Professor Lord, and was made as complete as possible. Every precaution was exercised in the collection of the samples for analysis. In the first place, two mine samples were obtained by the Survey field men, according to the rules prescribed for such work by the Geological Survey and the American Chemical Society. These samples were taken from widely separated portions of the mine, and were mailed in hermetically sealed galvanized-iron cans to the laboratory. As the car was unloaded at the plant it was carefully "sampled," and this sample was quartered down at the laboratory. As each distribution of the coal was made to the different portions of the plant for testing, this also was sampled and analyzed. Both proximate and ultimate analyses were made on car samples, and proximate analyses on the others. Calorimetric determinations (using a Mahler bomb calorimeter) were also made on



SCHAEFFER & BUDENBERG CALORIMETER.

SPECIMEN ANALYSES OF MINE AND LABORATORY CAR SAMPLES OF COAL.

		Arkansas No. 3.			Arkansas No. 5.			Colorado No. 1.		
		Mine sample A.	Mine sample B.	Laboratory car sample.	Mine sample A.	Mine sample B.	Laboratory car sample.	Mine sample B.	Mine sample A.	Laboratory car sample.
	Laboratory sample No.	1115	1118	1296	1130	1131	1331	1383	1397	1523
	Loss of moisture on air drying	0.80	0.80	1.40	0.70	1.30	1.10	3.90	4.00	6.00
	Analysis of air-dried sample.									
Proximate	Moisture	0.81	0.84	0.80	0.68	0.51	1.28	16.77	18.58	13.49
	Volatile matter	17.54	16.81	19.75	14.87	15.19	12.82	35.18	35.42	37.11
	Fixed carbon	73.68	69.59	67.65	77.45	76.94	73.69	44.29	42.38	43.03
Ultimate	Ash	7.97	12.76	11.80	7.00	7.36	12.21	3.76	3.62	6.37
	Sulphur	1.43	1.47	1.30	1.53	1.97	2.01	0.54	0.48	0.58
	Hydrogen	....	....	4.07	....	....	3.74	....	....	5.75
	Carbon	....	....	76.37	....	....	77.29	....	....	61.13
	Nitrogen	....	....	1.55	....	....	1.39	....	....	1.22
	Oxygen	....	....	4.91	....	....	3.36	....	....	24.95
	Calorific value determined:									
	Calories	7,931	....	7,586	8,017	....	7,448	5,918	....	5,995
	British thermal units	14,275	....	13,655	14,431	....	13,406	10,652	....	10,791
	Calorific value calculated from ultimate analysis:									
	Calories	....	....	7,393	....	....	7,434	....	....	5,859
	British thermal units	....	....	13,307	....	....	13,381	....	....	10,546
	Analysis corrected to sample as received.									
Proximate	Moisture	1.60	1.63	2.19	1.38	1.80	2.36	20.02	21.84	18.68
	Volatile matter	17.40	16.68	19.47	14.76	15.00	12.68	33.81	34.00	34.88
	Fixed carbon	73.09	69.03	66.71	76.91	75.94	72.88	42.56	40.68	40.45
Ultimate	Ash	7.91	12.66	11.63	6.95	7.26	12.08	3.61	3.48	5.99
	Sulphur	1.42	1.46	1.28	1.52	1.94	1.99	0.52	0.46	0.55
	Hydrogen	....	....	4.17	....	....	3.82	....	....	6.07
	Carbon	....	....	75.31	....	....	76.44	....	....	57.46
	Nitrogen	....	....	1.53	....	....	1.37	....	....	1.15
	Oxygen	....	....	6.08	....	....	4.30	....	....	28.78
	Calorific value determined:									
	Calories	7,868	....	7,480	7,961	....	7,366	5,687	....	5,635
	British thermal units	14,162	....	13,464	14,330	....	13,259	10,237	....	10,143
	Calorific value calculated from ultimate analysis:									
	Calories	....	....	7,289	....	....	7,353	....	....	5,507
	British thermal units	....	....	13,120	....	....	13,235	....	....	9,913

one of the mine samples and on the car samples. The preliminary report of the laboratory work gives the analyses of these samples only. The analyses of the other samples are given in connection with the results of each particular test.

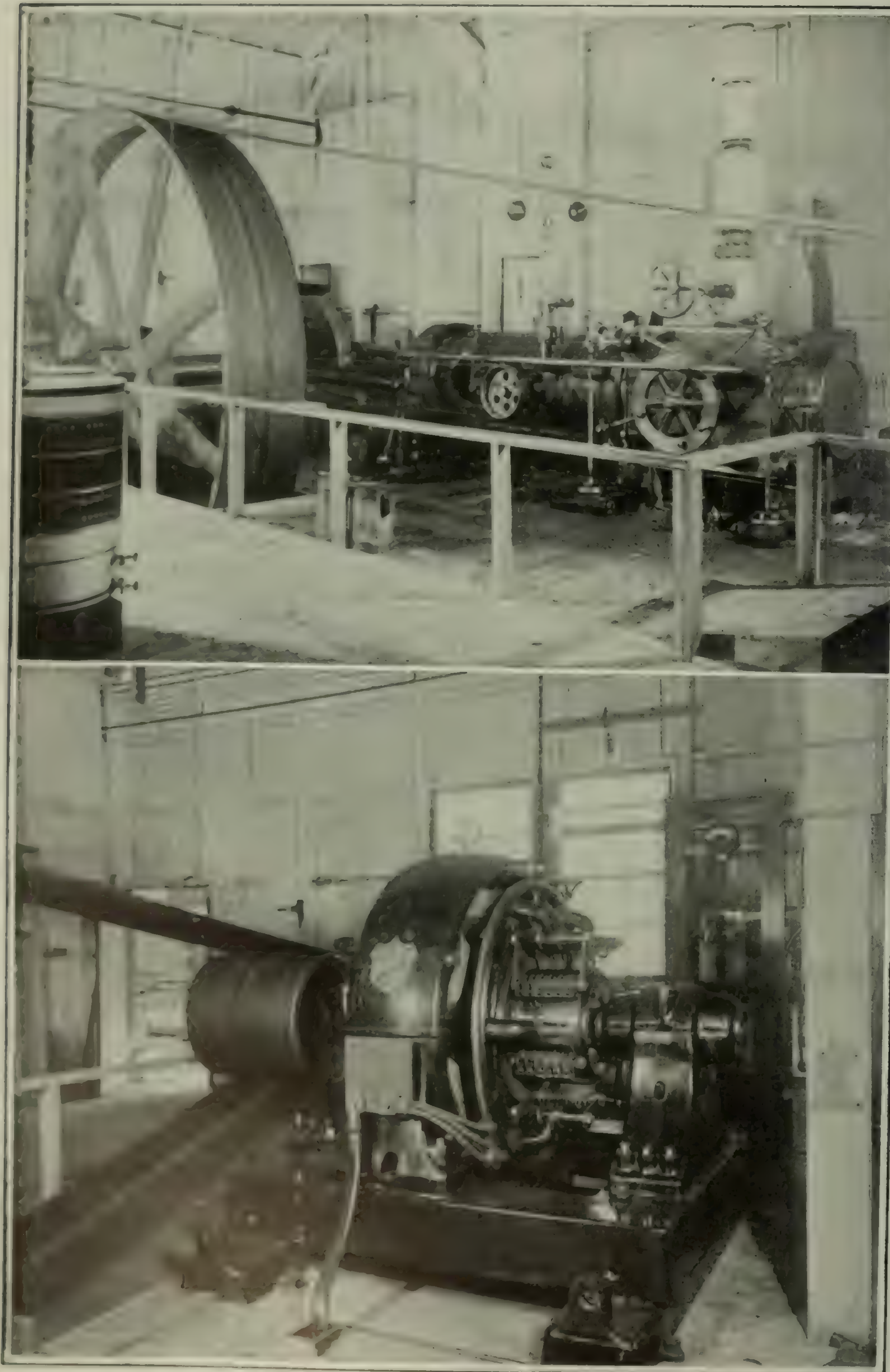
The table above gives a few of the analytical results. The complete table is too long to be printed in an article of this kind. Attention is particularly called to the very close accordance of the calorific values as shown by the calorimeter determination and by calculation from the ultimate analyses. In all but one or two instances the calculated results were very slightly less than the determined ones. Another point brought out by these analyses is the loss in moisture

SPECIMEN ANALYSES OF MINE AND LABORATORY CAR SAMPLES OF COAL.

Texas No. 1.			Texas No. 2.			West Virginia No. 1.			West Virginia No. 2.		
Mine sample B.	Mine sample A.	Laboratory car sample.	Mine sample A.	Mine sample B.	Gas-producer sample.	Mine sample B.	Mine sample A.	Laboratory car sample.	Mine sample B.	Mine sample A.	Laboratory car sample.
1195	1196	1456	1241	1243	1597	1088	1089	1213	1103	1104	1308
14.40	16.30	24.60	5.80	5.90	25.80	0.40	0.40	0.40	0.90	0.80	0.50
21.25	20.55	13.40	24.48	27.04	10.66	1.00	0.95	1.35	1.09	1.08	1.46
43.25	47.20	42.75	38.17	43.76	39.42	36.80	37.50	36.92	40.91	40.62	40.14
22.85	19.41	29.00	28.94	20.17	40.11	55.50	55.10	55.36	48.84	50.13	50.50
12.65	12.84	14.85	8.41	9.03	9.81	6.70	6.45	6.37	9.16	8.17	7.90
0.65	0.67	1.04	0.53	0.61	0.71	1.60	1.32	0.90	4.24	3.78	3.50
....	....	5.57	....	....	5.28	....	....	5.26	....	....	5.09
....	....	52.06	....	....	57.31	....	....	78.31	....	....	74.44
....	....	0.95	....	....	1.06	....	....	1.55	....	....	1.37
....	....	25.53	....	....	25.83	....	....	7.61	....	....	7.70
....	4,741	5,199	4,716	....	5,502	7,845	....	7,869	7,549	....	7,700
....	8,534	9,358	8,489	....	9,904	14,121	....	14,164	13,588	....	13,860
....	....	5,046	....	....	5,352	....	....	7,832	....	....	7,517
....	....	9,083	....	....	9,634	....	....	14,098	....	....	13,531
32.58	33.50	34.70	28.86	31.34	33.71	1.40	1.35	1.75	1.98	1.87	1.95
37.02	39.50	32.23	35.96	41.18	29.25	36.65	37.35	36.77	40.54	40.30	39.94
19.56	16.25	21.87	27.26	18.98	29.76	55.28	54.88	55.14	48.40	49.73	50.25
10.84	10.75	11.20	7.92	8.50	7.28	6.67	6.42	6.34	9.08	8.10	7.86
0.56	0.56	0.79	0.50	0.57	0.53	1.59	1.31	0.90	4.20	3.75	3.48
....	....	6.93	....	....	6.79	....	....	5.28	....	....	5.13
....	....	39.25	....	....	42.52	....	....	78.00	....	....	74.07
....	....	0.72	....	....	0.79	....	....	1.54	....	....	1.36
....	....	41.11	....	....	42.09	....	....	7.94	....	....	8.10
....	3,968	3,920	4,442	....	4,082	7,813	....	7,837	7,481	....	7,661
....	7,142	7,056	7,996	....	7,348	14,063	....	14,107	13,466	....	13,790
....	....	3,805	....	....	3,975	....	....	7,800	....	....	7,480
....	....	6,849	....	....	7,155	....	....	14,040	....	....	13,464

by air-drying. This loss in some bituminous coals was as high as 10 per cent., and in the case of Texas lignites, 25 per cent. Still another interesting feature is the difference in ash shown between the mine samples and the car samples, although in taking the samples at the mine every effort was made to secure a fair representation. In almost every case the car samples show a higher percentage of ash, the average excess being 2.5 per cent. for all analyses.

The "general number," such as Arkansas No. 3, etc., in this table, and subsequent ones, is given for identification with the list showing the mine and State from which each coal was shipped.



ALLIS-CORLISS ENGINE, 210 HORSE POWER, AND BULLOCK 250-VOLT DIRECT-CURRENT GENERATOR. USED IN THE STEAM-GENERATING TESTS.

Steam-Raising Tests.—The entire equipment of the steam-generating plant was installed in a building made of corrugated iron, nailed to a wooden framework. The building occupies a floor space of 2,300 square feet, and is divided into two parts by a partition, the boilers and other apparatus for steam-raising tests being in one room, the engines (steam and gas) and the generators in the other. The tests have all been made in the Heine boilers, which had entirely separate settings, so that trials could be run on one, while the other was being overhauled and cleaned. The boilers are of the following dimensions:—

Grate surface	square feet	40.55
Width of grate	feet	6.16
Length of grate	do	6.58
Height of furnace	inches	26
Approximate width of air spaces in grate	do	.5
Proportion of air space to whole grate surface	per cent	44
Area of chimney	square feet	7.67
Height of chimney above grate	feet	113.25
Length of flue connecting chimney	feet, direct	0
Kind of draft		Chimney.
Water-heating surface	square feet	2,031
Outside diameter of shell	inches	42.9
Length of shell (outside to outside of heads)	feet	21.6
Number of tubes		116
Diameter of tubes:		
Outside	inches	3.5
Inside	do	3.25
Length of tubes	feet	17.87
Superheating surface	square feet	0
Ratio of water-heating surface to grate surface	— to 1	50.1

The testing equipment used in the boiler trials consist of water-weighing tanks and scales, coal-weighing car and scales, calorimeters, thermometers, and pyrometers, draft gauges, and gas sampling and analyzing apparatus.

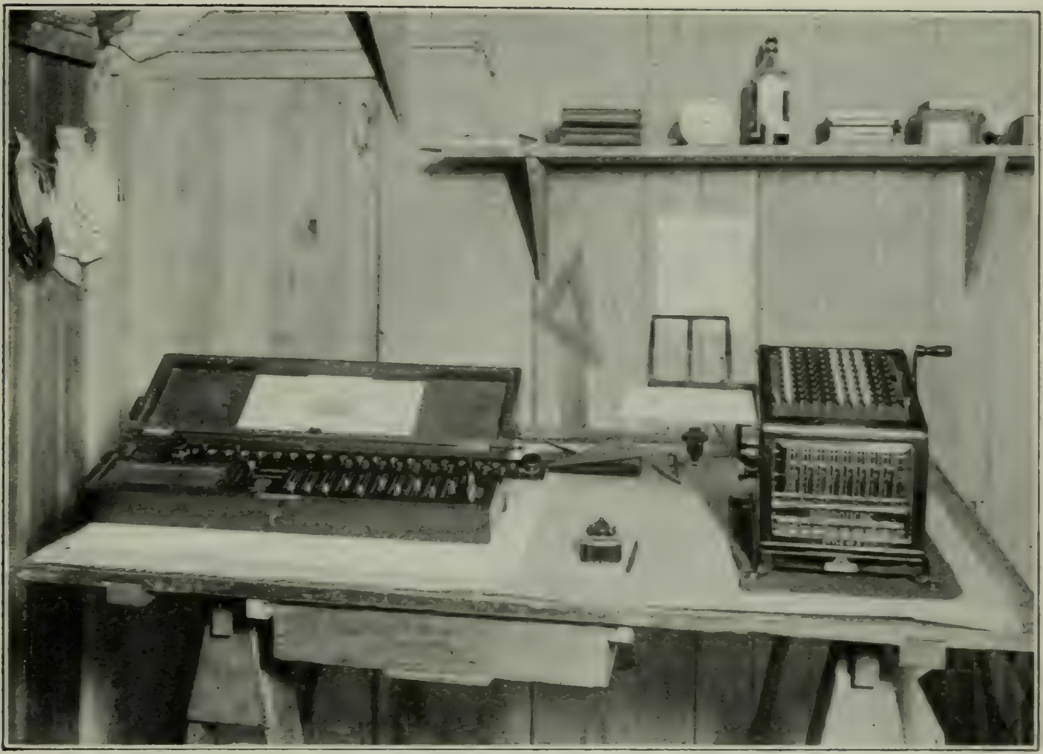
The duration of each trial was as nearly as possible ten hours, keeping in view only that at the beginning and the end of the tests the conditions of the fire should be as near alike as could be judged.

The object of the tests was to make boiler trials and to burn various coals under some standard boiler, and under what might be called fair conditions. Usually but a single trial could be made with each coal. In all the trials an effort has been made to maintain the rated horse power of the boiler in use.

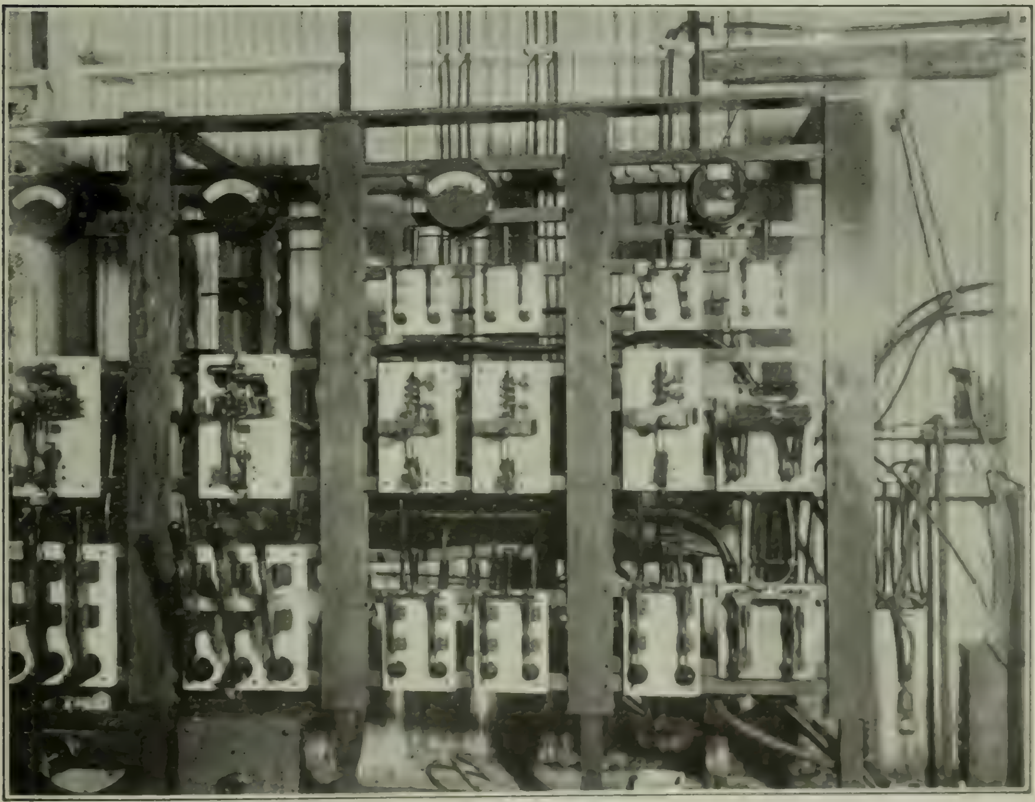
The tests have been made in accordance with the code of the American Society of Mechanical Engineers.

TABLE OF RESULTS OF COAL TESTS UNDER BOILERS.

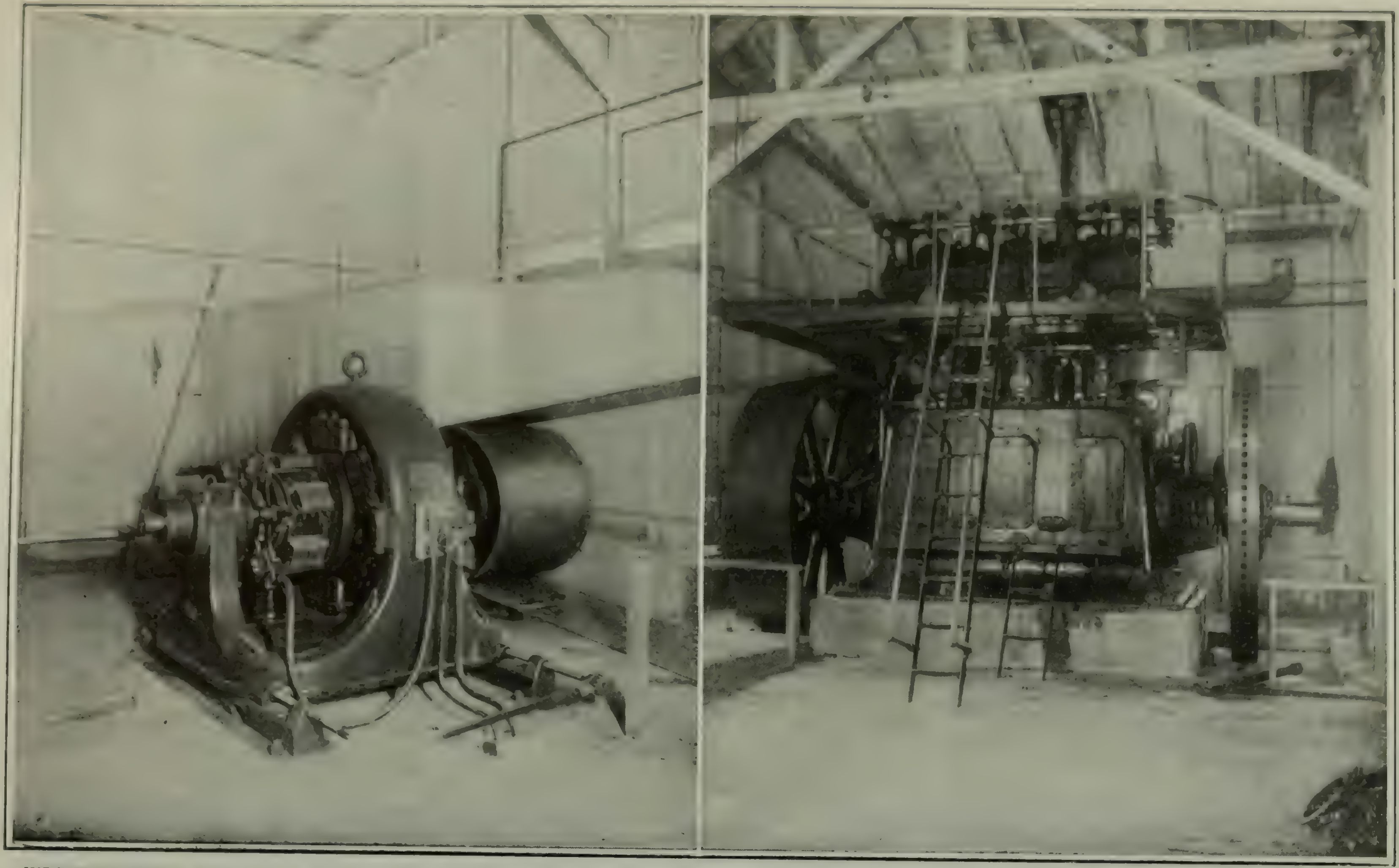
	Analysis of boiler-room sample.							Results.				
Name of Sample.	Fixed carbon.	Volatile matter.	Moisture.	Ash.	Sulphur separately determined.	Duration of trial.	Total coal consumed.	Horse power developed by boiler.	Dry coal burned per sq. ft. grate surface per hour.	Equivalent evaporation from and at 212° F. per pound of dry coal.	Dry coal per indicated horse power hour.	Dry coal per electrical horse power hour.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Hours.	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.
1	2	3	4	5	6	7	8	9	10	11	12	13
Alabama 1......	52.52	31.00	2.56	13.92	.78	10.03	8.656	205.8	20.72	8.44	3.35	4.14
do. briquetted	50.96	33.00	2.63	13.41	.94	8.25	6.521	196.6	18.97	8.81	3.21	3.96
Alabama 2......	48.65	32.98	4.83	13.54	1.17	10.02	9.198	216.4	21.54	8.55	3.31	4.08
Arkansas 1......	66.36	18.61	1.99	13.04	1.21	10.07	7,071	180.5	16.90	9.05	3.12	3.86
do. briquetted	67.65	21.21	.94	10.20	1.73	10.03	7,700	206.4	18.74	9.37	3.02	3.73
Arkansas 2......	73.65	16.86	1.07	8.42	1.95	10.07	6.517	180.6	15.70	9.73	2.91	3.59
do. briquetted	60.30	22.49	4.88	12.33	1.32	9.98	7.370	190.3	17.31	9.31	3.00	3.71
Arkansas 3.....	72.74	16.04	1.97	9.25	1.29	10.02	8.158	219.7	19.68	9.50	2.98	3.68
do. briquetted	62.04	17.35	2.60	18.01	1.41	10.08	8,600	200.8	20.49	8.34	3.39	4.19
do. 4. briq...	71.98	14.06	3.85	10.11	1.64	9.95	8.142	214.5	19.41	9.40	3.01	3.72
do. small do...	66.03	18.60	3.18	12.19	1.70	7.03	5.238	166.8	17.78	7.98	3.54	4.38
Arkansas 5......	73.68	12.54	2.22	11.56	2.39	10.13	9.000	202.4	21.42	8.04	3.52	4.34
Colorado 1......	39.00	35.85	19.78	5.37	.42	9.97	8.972	151.0	17.80	7.21	3.92	4.85
Illinois 1.......	38.21	36.91	9.69	15.19	4.40	9.93	11,124	211.4	24.90	7.21	3.92	4.85
do. 2. washed	41.72	37.77	10.45	10.06	3.36	9.97	10.096	210.2	22.36	8.00	3.54	4.38
Illinois 3.......	48.75	31.19	8.51	11.55	1.5	10,13	9.537	200.6	21.23	8.04	3.52	4.34
Illinois 4......	41.59	33.48	13.47	11.46	1.28	10.07	9.367	172.0	19.84	7.37	3.83	4.73
do. 4. 2d test	43.63	32.44	12.58	11.35	1.36	10.02	10,750	197.8	23.13	7.27	3.89	4.8
Illinois 6.......	39.62	32.31	13.19	14.88	3.48	9.92	10.343	194.3	22.34	7.4	3.82	4.72
Indiana 1, briq.	43.23	38.79	11.74	6.24	2.03	6.6	6.579	222.6	21.7	8.73	3.24	4.00
do. washed..	40.41	35.17	16.59	7.83	2.18	9.93	10,819	222.7	22.39	8.45	3.34	4.13
Indiana 2.......	40.40	38.04	9.11	12.45	4.12	10.13	9,274	193.4	20.51	8.02	3.53	4.35
Indian Ter. 1...	46.30	33.96	7.65	12.09	1.8	9.75	8.210	194.7	19.17	8.64	3.27	4.04
Indian Ter. 2...	50.31	36.21	3.71	9.77	1.39	10.17	9.213	212.9	21.5	8.42	3.36	4.15
Indian Ter. 3...	47.58	37.3	4.79	10.33	3.93	10.02	9.145	205.9	21.43	8.17	3.46	4.27
Indian Ter. 4...	45.33	35.44	6.24	12.99	3.86	10.22	9.296	186.1	21.04	7.53	3.76	4.64
Iowa 1..........	39.89	33.08	8.69	18.34	6.39	10.02	10.331	197.7	23.23	7.24	3.91	4.82
Iowa 2..........	33.73	35.35	14.88	16.04	4.73	9.92	10,986	192.7	23.28	7.05	4.01	4.95
Iowa 3..........	35.77	36.14	12.44	15.65	6.07	10.03	10.668	189.3	22.96	7.02	4.03	4.97
Iowa 4. briq...	37.85	36.50	13.24	12.41	3.90	10.03	9,900	184.5	21.11	7.43	3.80	4.70
Iowa 5..........	38.83	31.76	16.01	13.40	3.09	9.98	11.200	204.7	23.23	7.50	3.77	4.60
Kansas 1.......	49.46	33.78	5.90	10.86	3.82	10.10	7.222	158.2	16.60	8.11	3.49	4.31
Kansas 1.......	48.57	32.68	4.80	13.95	4.94	9.70	7,492	184.	18.13	8.63	3.28	4.05
Kansas 2.......	46.68	31.23	4.18	17.91	6.27	7.00	5,600	181.5	18.90	8.17	3.46	4.29
do. washed..	51.22	34.32	5.82	8.64	3.77	9.38	8,111	209.8	20.08	8.89	3.18	3.93
Kansas 3.......	50.99	33.52	2.03	13.46	5.39	9.91	7,700	169.6	18.77	7.69	3.68	4.55
do. 2d test	51.05	34.30	2.25	12.40	4.80	10.40	7,101	148.8	16.45	7.69	3.68	4.55
Kansas 4.......	43.59	36.32	5.51	14.58	8.46	10.05	7,835	165.5	18.18	7.75	3.65	4.51
Kentucky 1.....	55.59	35.61	2.89	5.91	1.19	10.03	8.355	212.3	19.95	9.06	3.12	3.86
Kentucky 2.....	45.75	37.91	7.76	8.58	3.37	10.00	9.557	208.5	21.75	8.16	3.47	4.28
do. briq..	44.32	37.07	7.11	11.50	3.71	9.82	9.371	207.1	21.87	8.06	3.51	4.33
Kentucky 3.....	44.84	37.32	7.92	9.92	3.91	10.07	9.645	211.5	21.75	8.27	3.42	4.22
Kentucky 4.....	45.74	35.65	5.89	12.72	3.72	9.93	9.386	211.7	21.90	8.21	3.44	4.25
Missouri 1......	40.64	34.88	7.28	17.20	4.37	10.00	9.737	207.4	22.30	7.92	3.57	4.41
do. briq.	41.85	37.60	6.38	14.17	4.56	5.10	4.500	191.2	20.37	7.99	3.54	4.37
do. washed	44.21	36.81	7.93	11.05	3.58	9.91	9.041	207.0	20.71	8.50	3.33	4.11
Missouri 2......	37.33	32.88	13.09	16.70	4.92	9.98	11.650	208.2	25.00	7.08	3.99	4.93
do. 2d test.	39.76	31.77	11.57	16.90	4.60	9.98	9.248	172.5	20.20	7.26	3.90	4.81
Missouri 3......	29.98	26.18	18.63	25.21	3.85	9.95	10.828	149.5	21.85	5.82	4.86	6.00
do. washed	39.61	31.18	20.78	8.43	2.88	9.93	11.044	189.7	21.72	7.43	3.81	4.70
Missouri 4......	42.11	40.10	12.24	5.55	4.98	9.98	9.515	214.1	20.64	8.83	3.20	3.96
New Mexico 1..	41.57	37.85	11.90	8.68	.56	10.05	10.963	206.3	23.70	7.41	3.96	4.90
New Mexico 2..	36.11	37.30	9.92	16.67	1.13	10.00	11.870	198.5	26.37	6.41	4.41	5.15
do. briq.	39.07	37.56	6.75	16.62	1.61	8.12	7.765	185.8	22.00	7.19	3.93	4.86
North Dakota 1	25.40	28.13	35.84	10.63	1.68	9.85	10.680	108.9	17.15	5.40	5.24	6.47
Pennsylvania 1	75.69	15.80	1.10	7.41	1.49	9.88	6.365	166.9	15.70	9.04	3.11	3.84
Pennsylvania 2	76.76	16.61	.59	6.04	.91	10.08	6.835	191.2	16.60	9.79	2.89	3.57
do. 2. briq.	55.00	27.62	3.00	14.38	1.13	10.08	8.012	184.5	19.01	8.26	3.42	4.23
West Virginia 1.	56.25	34.64	1.90	7.21	.98	9.98	7,818	199.2	18.94	8.95	3.16	3.90
West Virginia 2	48.80	39.23	2.01	9.96	2.71	10.22	8.354	212.4	19.75	9.14	3.09	3.82
West Virginia 3	[illegible]	[illegible]	2.54	11.64	1.38	9.97	8.225	211.6	19.82	9.08	3.11	3.84
West Virginia 4	59.84	27.64	2.53	9.99	.96	10.00	7.895	215.1	18.98	9.65	2.93	3.62
West Virginia 5	[illegible]	28.65	2.11	10.28	1.01	10.08	7.700	207.8	18.44	9.59	2.95	3.81
West Virginia 6.	70.03	22.38	2.14	5.45	.70	9.95	7.406	213.2	17.95	10.09	2.80	3.46
do. 2d test	71.42	21.44	2.11	5.03	.64	10.18	7.264	208.5	17.21	10.30	2.74	3.39
West Virginia 7.	68.27	20.23	2.68	8.82	1.52	10.18	7.700	210.1	18.15	9.85	2.87	3.55
West Virginia 8.	[illegible]	[illegible]	5.26	6.87	.74	9.98	7.997	211.6	18.72	9.62	2.94	3.63
West Virginia 9.	[illegible]	[illegible]	2.42	6.06	.82	10.00	7.464	210.8	17.78	10.09	2.80	3.46
West Virginia 10	77.84	14.23	1.74	6.19	.59	9.93	7.441	205.9	18.15	9.65	2.93	3.62
West Virginia 11	[illegible]	[illegible]	4.85	10.48	.47	9.97	7.700	213.7	18.13	10.03	2.82	3.48
West Virginia 12	[illegible]	[illegible]	1.58	4.83	.59	10.13	7.399	206.1	17.68	9.90	2.86	3.53
do. 2 briq.	[illegible]	23.02	2.32	6.20	.84	10.25	7.515	211.8	17.66	10.20	2.77	3.42
Wyoming 1....	31.61	40.56	21.81	6.02	.63	10.15	11.946	186.6	22.69	7.00	4.04	4.99
Wyoming 2....	[illegible]	[illegible]	11.10	18.77	3.87	9.95	12.028	184.3	26.51	5.92	4.77	5.90



CALCULATING MACHINES.

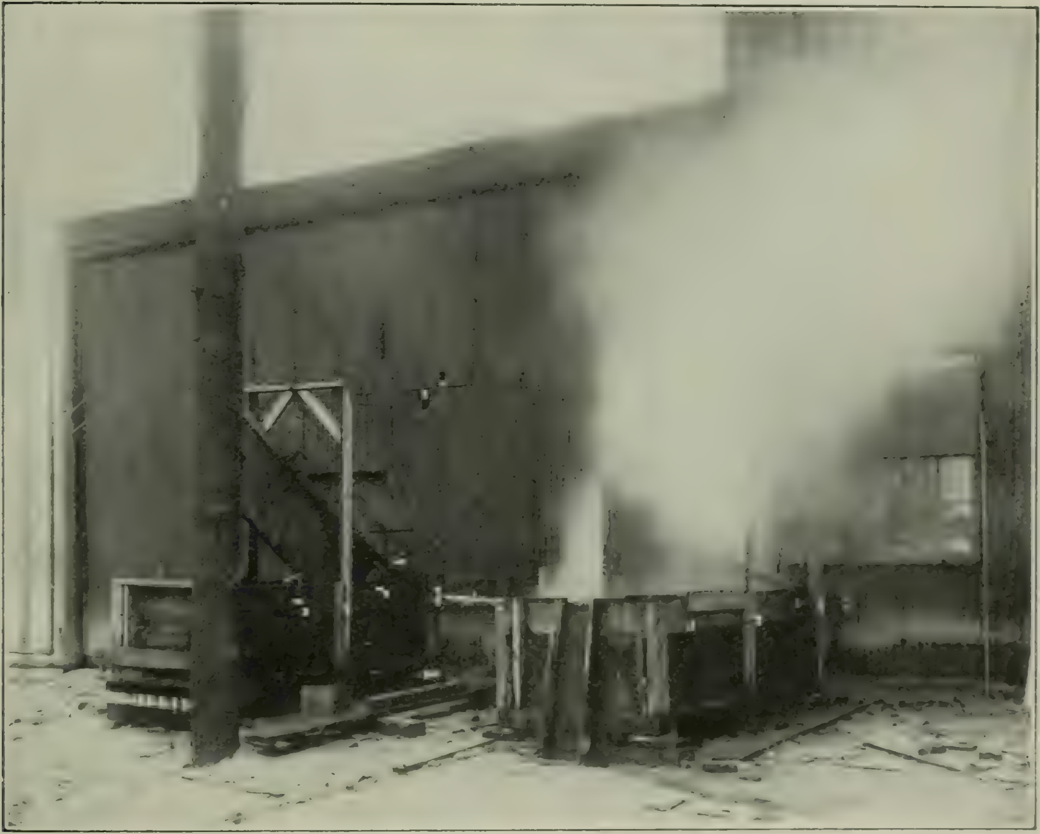


THE SWITCHBOARD.



WESTINGHOUSE 235-BRAKE-HORSE-POWER THREE-CYLINDER GAS ENGINE AND 250-VOLT DIRECT-CURRENT GENERATOR. USED IN THE GAS-PRODUCING TESTS.

A brief summary of the results obtained in the steam-generating tests is given in the table on page 34. It will be noted that there were eight tests of briquettes (three of Arkansas coals, one of Alabama, one of Kentucky, one of Missouri, one of New Mexico, and one of West Virginia), which may be compared with tests of the coal from which the briquettes were made. In five of these instances the fuel consumption per electrical horse power developed was in favor of the briquettes, and in three it was in favor of the coal unbriquetted.



THE WATER RHEOSTATS.

In three cases, where tests were made of washed coal, the results were all substantially favorable to the washed fuel. In one case, particularly, that of Missouri No. 3, the fuel consumption per electrical horse power was reduced from 6 pounds for the unwashed coal to 4.7 pounds for the washed coal. The ash contents of the coal were reduced by washing from 25.21 per cent. to 8.43 per cent.

Space limitations compel an intermission at this point. In a succeeding number of THE ENGINEERING MAGAZINE will be presented the gas-producing, coking, and briquetting tests, with their results concisely tabulated and the steam-generating and gas-producing efficiencies of the fuels comparatively presented; and with these will be the experiments with various binders for briquetted fuels.

LIST OF CAR SAMPLES OF COAL TESTED DURING THE SEASON OF 1904 AT THE U. S. GEOLOGICAL SURVEY FUEL-TESTING PLANT AT THE LOUISIANA PURCHASE EXPOSITION.

Alabama.

No. 1. Lump and nut coal from mine No. 8 of the Ivy Coal & Iron Co., located at Horse Creek, Ala.

No. 2. Lump, nut, and pea coal from mine No. 5 of the Galloway Coal Co., located at Carbon Hill, Ala.

Arkansas.

No. 1. Lump and nut coal from mine No. 3 of the Central Coal & Coke Co., located at Huntington, Ark.

No. 2. Lump coal from mine No. 12 of the Central Coal & Coke Co., located at Bonanza, Ark.

No. 3. Lump and slack coal from mine No. 18 of the Western Coal & Mining Co., located at Jenny Lind, Ark.

No. 4. Slack coal from several Arkansas mines furnished by the Union Fuel Co., St. Louis, Mo.

No. 5. Lump and slack coal from mine No. 4 of the Western Coal & Mining Co., located at Coal Hill, Ark.

No. 6. Slack coal from mine No. 18 of the Western Coal & Mining Co., located at Jenny Lind, Ark.

Colorado.

No. 1. Run-of-mine black lignite from Simpson mine of the Northern Coal & Coke Co., located at Lafayette, Colo.

Illinois.

No. 1. Lump and nut coal from mine No. 1 of the Western Anthracite Coal & Coke Co., located near O'Fallon, Ill.

No. 2. Slack coal from same as Illinois No. 1.

No. 3. Run-of-mine coal from mine No. [illegible] of the Southern Coal Mining & Washing Co., located near Marion, Ill.

No. 4. Lump coal from mine No. 3 of the Donk Bros. Coal & Coke Co., located at Troy.

No. 5. Washed slack from mine No. [illegible] of Donk Bros. Coal & Coke Co., located near Collinsville, Ill.

No. 6. Run-of-mine coal from shaft No. [illegible] of Clover Leaf Coal Co., located at Coffeen, Ill.

Indian Territory.

No. 1. Lump and slack coal from mine No. 1 of the Whitehead Coal & Mining Co., located at Henryetta, I. T.

No. 2. Run-of-mine coal from mine No. 8 of the Rock Island Coal Co., located at Hartshorne, I. T.

No. 3. Run-of-mine coal from mine No. 1 of D. Edwards & Son, located at Edwards, I. T.

No. 4. Lump coal from mine No. 5 of the Western Coal & Mining Co., located at Lehigh, I. T.

No. 5. Slack and pea coal from mine No. 7 of the Western Coal & Mining Co., located at Lehigh, I. T.

No. 6. Slack coal from Southwestern Development Company's mines at Coalgate, I. T.

Indiana.

No. 1. Run-of-mine coal from Mildred mine of the J. Wooley Coal Co., located at Mildred, Ind.

No. 2. Run-of-mine coal from Electric mine of the T. D. Scales Coal Co., located at Boonville, Ind.

Iowa.

No. 1. Lump and fine coal from mine No. 2 of the Anchor Coal Co., located at Laddsdale, Ia.

No. 2. Run-of-mine coal from mine No. 6 of the Mammoth Vein Coal Co., located at Hamilton, Ia.

No. 3. Lump coal from mine No. 4 of the Gibson Coal Mining Co., located near Altina, Ia.

No. 4. Lump coal from mine No. 3 of the Centerville Block Coal Co., located at Centerville, Ia.

No. 5. Run-of-mine coal from Inland mine No. 1 of the Inland Fuel Co., located at Chariton, Ia.

Kansas.

No. 1. Coal from mine No. 10 of the Western Coal & Mining Co., located at Fleming, Kans.

No. 2. Lump, nut, and slack from mine No. 11 of the Western Coal & Mining Co., located at Yale, Kans.

No. 3. Run-of-mine coal from mine No. 9 of the Southern Coal & Mercantile Co., located at Scammon, Kans.

Kansas.

No. 4. Lump coal from mine of the Atchison Coal Mining Co., located at Atchison, Kans.

No. 5. Lump and nut coal from mine No. 11 of the Southwestern Development Co., located at West Mineral, Kans.

Kentucky.

No. 1. Run-of-mine coal from Straight Creek mine No. 2 of the National Coal & Iron Co., located at Straight Creek, Ky.

No. 2. Lump, nut, pea, and slack coal from mine No. 1 of the St. Bernard Mining Co., located at Earlington, Ky.

No. 3. Run-of-mine coal from Bramsley mine of the St. Bernard Mining Co., located nead Earlington, Ky.

No. 4. Run-of-mine coal from mine of the Wheatcroft Coal & Mining Co., located at Wheatcroft, Ky.

Missouri.

No. 1. Run-of-mine coal from New Home mine No. 1 of the New Home Coal Co., located at Sprague, Mo.

No. 2. Run-of-mine coal from mine No. 8 of the Northwestern Coal & Mining Co., located near Bevier, Mo.

No. 3. Slack coal from mine of the Mendota Coal & Mining Co., located near Mendota, Mo.

No. 4. Run-of-mine coal from mine of Morgan County Coal Co., located near Barnet. Mo.

Montana.

No. 1. Washed nut coal from mine near Red Lodge, Mont.

New Mexico.

No. 1. Lump and slack coal from Weaver mine of the American Fuel Co., located three miles north of Gallup, N. M.

No. 2. Slack coal from Otero mine of the Caledonian Coal Co., located two miles east of Gallup, N. M.

North Dakota.

No. 1. Run-of-mine brown lignite from Lehigh, N. D.

No. 2. Run-of-mine brown lignite from mine of the Cedar Coulee Coal Co., located four miles southeast of Williston, N. D.

Texas.

No. 1. Brown lignite from mine of the Houston County Coal & Mfg. Co., located eleven miles south of Crockett, Tex.

No. 2. Brown lignite from Consumers' Lignite Co., located at Hoyt, Tex.

West Virginia.

No. 1. Run-of-mine coal from mine of the Virginia & Pittsburg Coal Co., located at Kingmont, W. Va.

No. 2. Run-of-mine coal from Pitcairn Mine of the Pitcairn Coal Co., located at Clarksburg, W. Va.

No. 3. Run-of-mine coal from mine of West Virginia Coal Co., located at Richard, W. Va.

No. 4. Run of-mine coal from mine of the West Virginia Coal Co., located at Bretz, W. Va.

No. 5. Lump and nut coal from mine of the Davis Colliery Co., located at Coalton, W. Va.

No. 6. Run-of-mine coal from mine of the New River Smokeless Coal Co., located at Rush Run, W. Va.

No. 7. Run-of-mine coal from mine of the New River Smokeless Coal Co., located at Sun Switch, W. Va.

No. 8. Run-of-mile coal from mine of the Gauley Mountain Coal Co., located at Ansted, W. Va.

No. 9. Run-of-mine coal from Vulcan mine of the Mt. Carbon Company, Ltd., located at Powellton. W. Va.

No. 10. Lump and run-of-mine coal from mine of the Sagamore Colliery Co., located at Mora, W. Va.

No. 11. Run-of-mine coal from mines Nos. 1 and 2 of the W. H. Coffman Coal & Coke Co., located at Zenith, W. Va.

No. 12. Run-of-mine coal from mine of the Big Sandy Coal & Coke Co., located at Big Sandy, W. Va.

Wyoming.

No. 1. Black lignite from mine of the Wyoming Coal & Mining Co., located at Monarch, Wyo.

No. 2. Black lignite from mine of the Cambria Fuel Co.

THE COST SYSTEM OF AN ENGINEERING WORKS.

By H. Deighton.

In point of comprehensive provision for cost keeping, stock tracing, stores control, and general accounting, the system described by Mr. Deighton appears one of the most effective we have published. And with its efficiency it combines great practicability and simplicity.—The Editors.

THE engineering works in which the cost system herein dedescribed is in operation has been chosen as being one in which the conditions were unusually favorable for the installation and successful operation of a complete system. The general organization and accounting are also incidentally referred to.

Here are built large stationary engines as well as small machines, the parts of which have been standardized as far as possible. Considerable jobbing work, a good deal of which is in the form of repairs, is also done. The company has no foundry of its own, all brass, iron, and other castings being purchased from nearby foundries. On an average, something like 800 hands are employed in the works, about 30 per cent. of whom are piece workers, and the remainder day workers. In addition, about 50 men are employed on the road, who are engaged chiefly in erecting engines and making repairs.

There are in the factory nine productive and partially productive departments. In order to distinguish these more clearly from the non-productive departments, such as the store house, the power plant, etc., they will be referred to in the following as the "productive" departments. Department numbers have been allotted to each of them, which are:—

Blacksmith's shop	Department	No.	1
Carpenter's shop	"	"	2
Pattern shop	"	"	3
Boiler shop	"	"	4
Tool room	"	"	5
Large machine shop...............	"	"	6
Small machine shop...............	"	"	7
Assembling room	"	"	8
Erecting shop	"	"	9

There is a department foreman in each of these, and also a department clerk who is employed chiefly in the making out of time slips and piece-work vouchers, ordering of material, keeping track of orders, and doing any other clerical work, and occasionally some other duties. The storehouse is located as centrally as possible, in order to avoid any unnecessary handling of material. Here is the store-keeper's office, Adjoining it is the superintendent's office. The secretary of the company, who is in charge of the general office or accounting department, also supervises the cost system and other clerical work of the factory.

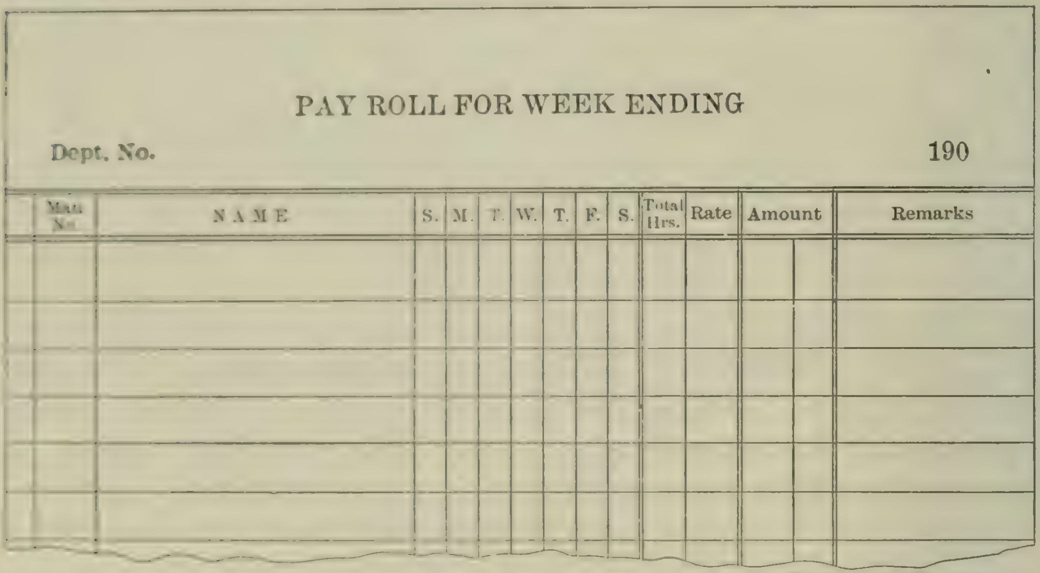
Little need be said about the general books in the accounting department, which are concise and up-to-date. They consist chiefly of the following: Petty cash book, bank cash book, purchase journal, sales journal, general journal, general ledger. There is nothing unusual about any of these except the sales journal, a reduced copy of which is illustrated by Form No. 10. At the extreme left will be noticed two additional columns headed "Trading a/c" and sub-headed "Stores" and "Manufacturing," into which cost prices are entered. These are used in connection with the monthly revenue account and balance sheet, and will be again referred to.

The purchase ledger and the sales ledger are subsidiary books, represented by controlling accounts in the general ledger. The cost ledgers, which are subsidiary ledgers, are kept in the accounting department, and are controlled by the "Manufacturing" account in the general ledger. The stores ledgers, too, are subsidiary, and controlled by the "Stores" account in the general ledger. They are, however, kept in the store-house.

Shipping orders emanate from the sales department, and bear consecutive numbers. Before going to the shipping clerk they pass through the superintendent's office, where inquiry is made as to whether the goods are in stock or have to be made specially in the factory; which information is noted on them for the guidance of the shipping clerk. If the goods are in stock, the shipping clerk draws them out of the storehouse on stores warrants (see Form No. 6). If they have to be made specially, they will, when ready, be delivered to him by one of the productive departments, shop orders (see Form No. 2) having in the meantime been issued from the superintendent's office instructing the foremen of the different departments interested.

On executing a shipping order, the shipping clerk turns it in to the accounting department. After the selling prices have been noted on it by the sales department, it forms, in the hands of the billing clerk, the basis of an invoice to the customer. Shipping orders are consecutively numbered before being issued, and as a hard-and-fast rule has been laid down and is strictly adhered to that no goods whatsoever must leave the factory except in execution of written shipping orders, it tends to eliminate the possibility of any omission to bill goods, and moreover facilitates the auditing of the sales journal.

The shop order used is illustrated by Form No. 2, which has been reduced in size. These are thin cards, and are issued only from the superintendent's office, as instruction to the department foremen. They are all consecutively numbered as issued, and specify fully the work to be done, give reference to the drawing number and piece or pattern number, and state where the goods must be delivered.



PAY ROLL FOR WEEK ENDING

Dept. No. 190

	Man No.	NAME	S.	M.	T.	W.	T.	F.	S.	Total Hrs.	Rate	Amount		Remarks

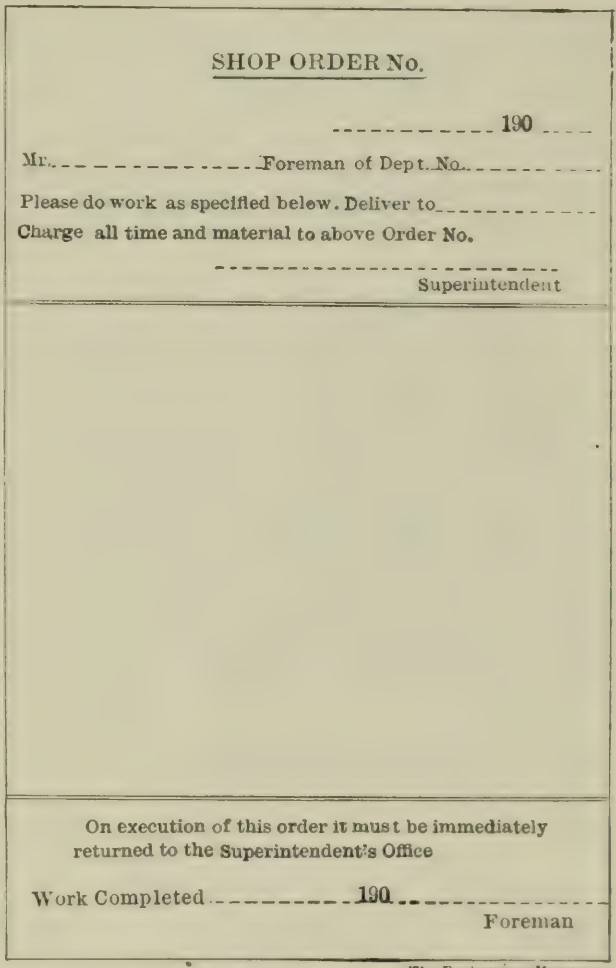
The Engineering Magazine

FORM I. PAY ROLL. REDUCED SIZE.

Sometimes all the work on a shop order can be done in one department, in which case an order is issued to that foreman only. But in most cases the work has to be done in more than one department, thus necessitating the issuing of more than one shop order. Of course these all bear the same number, and only such instructions are given to each foreman as necessarily concern him. As the work is passed on by one department to another, the recipient signs for it on the back of the shop order, which is immediately returned to the superintendent's office. On issuing a shop order, a course tag (see Form No. 3), on which is noted the shop-order number and brief description of the article or work, is also issued to the foreman of the first department engaged on it. This tag is attached to one of the articles and accompanies it throughout its course, till the work is finished and delivered to the store keeper or the shipping clerk, thus affording a means by which work in progress can be readily identified at all times.

Instructions have been issued that no work must be done in the factory except in execution of written shop orders, which rule is kept as hard-and-fast as possible; still there are a few exceptions, such as in the case of a blacksmith or tool maker tempering or repairing tools, or doing other similar petty jobs which take less than say ¼ hour's time, or in the case of a floor sweeper or general laborer, whose time is always indirect. These exceptions, however, and the extent of them, have been pretty well defined and are clearly understood throughout the works.

Shop orders are divided into three classes, for each of which a separate series of numbers has been reserved, so as to distinguish them more clearly. They are: "Personal" shop orders, "Stock" shop orders, and "Plant" shop orders.



SHOP ORDER No.

------------ 190 ----

Mr. ------------- Foreman of Dept. No. ------------

Please do work as specified below. Deliver to ------------

Charge all time and material to above Order No.

-------------------------- Superintendent

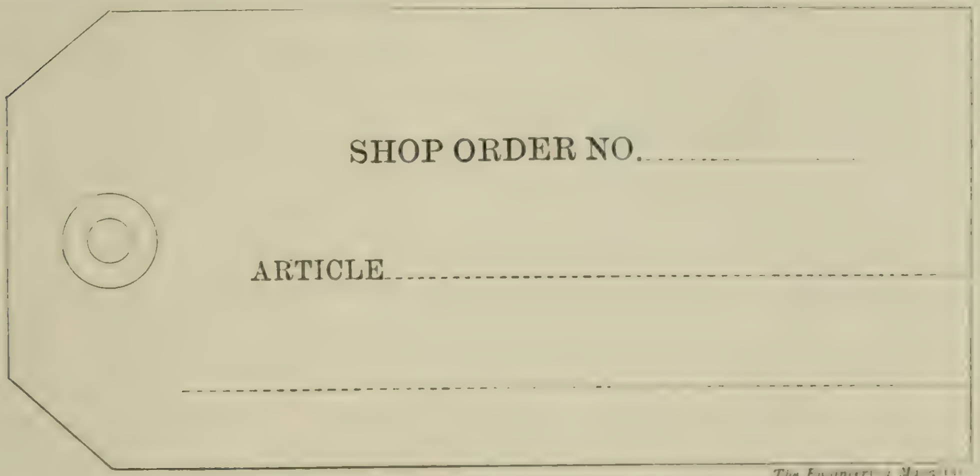
On execution of this order it must be immediately returned to the Superintendent's Office

Work Completed ---------- 190 ----------------

Foreman

The Engineering Magazine

FORM 2. SHOP ORDER. REDUCED SIZE.



SHOP ORDER NO. ....

ARTICLE --

The Engineering Magazine

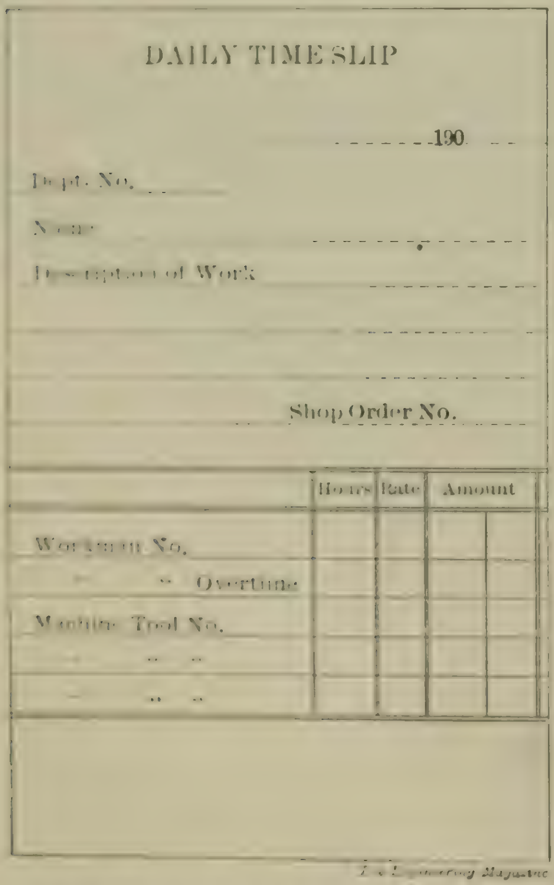
FORM 3. COURSE TAG. FULL SIZE.

"Personal" shop orders are issued in execution or partial execution of shipping orders, the work being done specially for some customer, and on completion delivered to the shipping clerk. These always bear the same number as the shipping order, though if the shipping order calls for two or more entirely different articles, separate costs of which are desired, two or more shop orders are issued, the numbers of which are further distinguished; as for instance, No. 1706—1, and No. 1706—2, which two shop orders are issued on account of shipping order No. 1706.

"Stock" shop orders are issued to produce articles for stock, which on completion are delivered to the store keeper.

"Plant" shop orders are issued to produce new articles of plant and equipment, make repairs and alterations, or do any other work which partakes of the nature of an expense around the factory. It is left to the accounting department to determine whether the cost of these is a charge to capital or to revenue, and to which accounts.

In order that the superintendent and his clerk may keep proper track of all work in progress in the factory, the following system has been devised:—There is in the superintendent's office a card case which is in the form of an open sloping frame. It is divided into three sections, one for each of the different classes of shop orders. Immediately a shop order is issued, a copy of it is made out and inserted in this card frame. If it is issued to more than one department, the card for the frame gives only a brief description of the work, and states at the top which of the departments have been instructed. Each card remains in the card frame till the order it represents is finished, when it is taken out and filed away. As soon as a foreman finishes his portion of the work and delivers it to the next department, he returns his shop-order card to



DAILY TIME SLIP

190

Dept. No.

Name

Description of Work

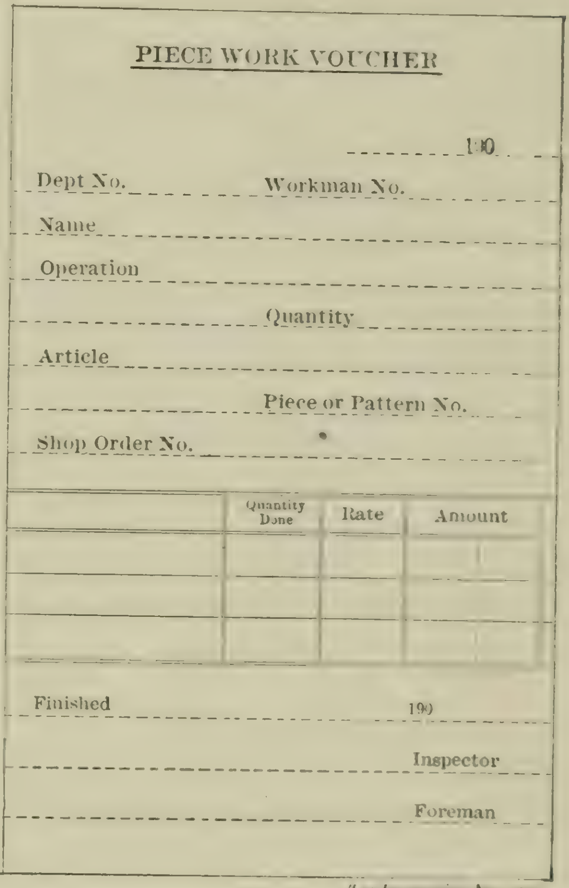
Shop Order No.

	Hours	Rate	Amount	
Workman No.				
" " Overtime				
Machine Tool No.				
" "				
" "				

The Engineering Magazine

FORM 4. DAILY TIME SLIP. ORIGINAL IS 3½ BY 5½ INCHES.

the superintendent's office, where it is also deposited in its proper place in the card frame. This enables the superintendent or his clerk to tell immediately, without leaving the office, in which department an order is being worked on at any time, and thus have some idea as to how near completion it is.



PIECE WORK VOUCHER

190

Dept No. Workman No.

Name

Operation

Quantity

Article

Piece or Pattern No.

Shop Order No.

	Quantity Done	Rate	Amount

Finished 190

Inspector

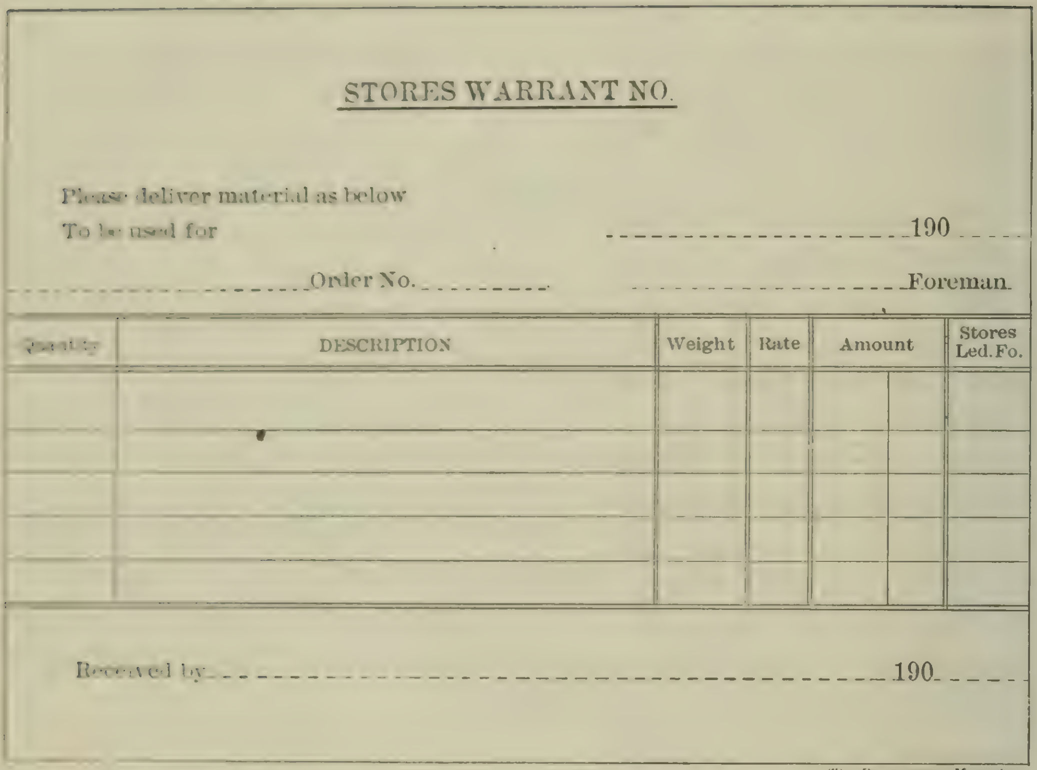
Foreman

The Engineering Magazine

FORM 5. PIECE-WORK VOUCHER. ORIGINAL IS 3½ BY 5½ INCHES.

Each workman on being hired is allotted a register number. On entering and leaving the factory he registers his time at the gate by means of an automatic time-recording clock, of which there are several good kinds in the market, which are fast superseding the old-fashioned method of registering by using brass checks. From the records of this register the numbers of hours put in by each man each day is credited to him daily on the weekly pay-roll (see Form No. 1); the cross footing of these hours at the end of the week gives his total number of hours, which multiplied by his rate, brings the amount of his pay for the week. When a man works overtime two lines are used for him, as the overtime is figured at an increased rate per hour. The time so recorded, though taken as evidence of presence at work, is further verified as explained below. Separate pay rolls are made up for each department. The same form of pay roll is used for piece workers, each man's number of hours each day being filled in, but the amounts credited are obtained from the piece-work vouchers turned in. (See Form No. 5.)

No ledger accounts are kept with the workmen, nor do advances to piece workers on account of unfinished piece work appear on the pay roll; such payments are considered as loans, and small specially printed I. O. U. cards made out for them, O. K.'d by the superintendent. These the cashier surrenders to the men through the paymaster for the refund of the money so advanced on pay days.



STORES WARRANT NO.

Please deliver material as below
To be used for ____________________190____

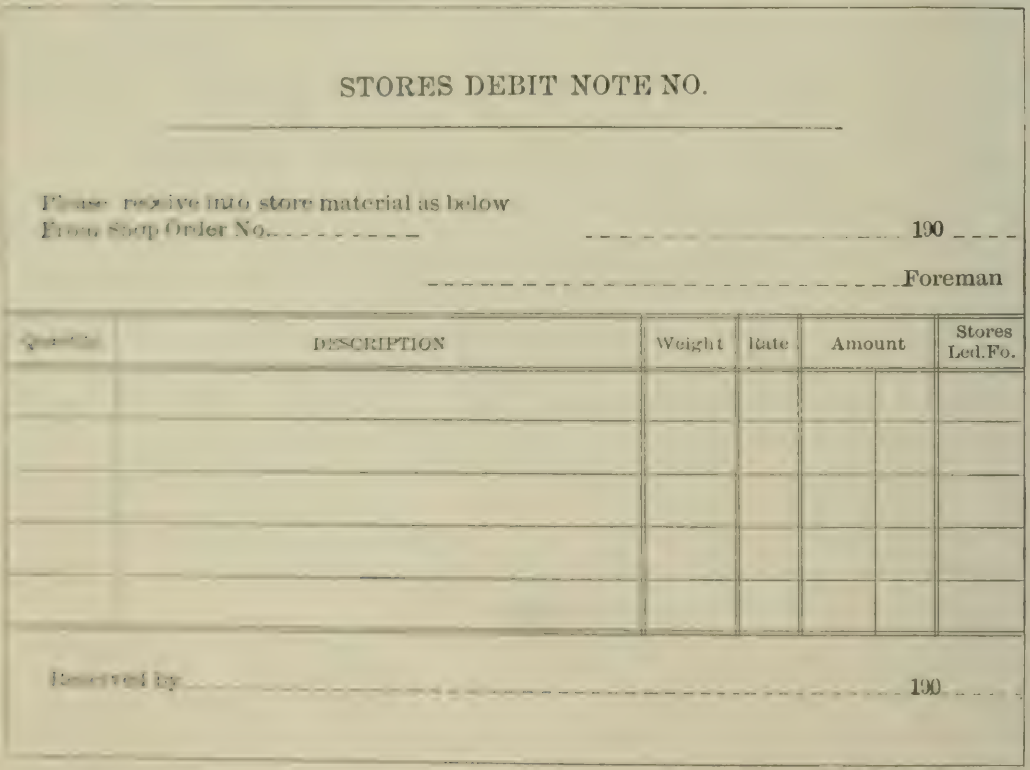
____________________Order No.__________ ____________________Foreman.

Quantity	DESCRIPTION	Weight	Rate	Amount		Stores Led. Fo.

Received by____________________________________190____

The Engineering Magazine

FORM 6. STORES WARRANT. ORIGINAL IS ABOUT 5½ BY 4 INCHES.



STORES DEBIT NOTE NO.

Please receive into store material as below
From Shop Order No.__________ ____________________190____

____________________________Foreman

Quantity	DESCRIPTION	Weight	Rate	Amount		Stores Led. Fo.

Received by____________________________________190____

The Engineering Magazine

FORM 7. STORES DEBIT NOTE. ORIGINAL IS ABOUT 5½ BY 4 INCHES.

Form No. 4 is a reduced copy of the daily time slips, which are used by both day workers and piece workers, though those for the day workers are on white and those for the piece workers on buff-tinted paper. These forms are padded by the printer in pads of fifty each, so as to be convenient for use in the departments. A workman on commencing a job is handed one of these time slips by his department clerk. The latter, as he handles the shop orders, has ready access to all the information necessary in the making out of these slips. On completion of the job, this slip is handed back by the workman to the clerk, who fills in the number of hours, and gives the man a slip for the next job on which he is going to work. The clerk O. K.'s all these slips, and turns them into the accounting department at night or early next morning. The slips for such jobs as are unfinished at night are also turned in, and new ones issued to the men in the morning. These slips are then priced and extended by the cost clerks, the amounts on the day-worker's slips being summarized and charged to the different cost sheets representing the shop orders on which they apply.

On the time slips made out for the few men who do work for which no formal written shop orders have been issued, is recorded briefly the nature of such work. "Standing order numbers" are no longer used, having been considered undesirable and abolished.

Piece workers on commencing jobs are also handed piece-work vouchers (see Form No. 5) by the department clerks, which are issued in duplicate. These are retained by the workmen until the work is finished, which may be several hours or several days, when after being O. K.'d by the inspector and the foreman, they are turned into the accounting department. Here, after being summarized in a memorandum book, the amounts are credited to the workman on the weekly pay roll. After this they are passed to the cost clerks to be charged up on the cost sheets, when any difference in or duplication of quantities should be at once detected. The duplicates, which are also O. K.'d by the inspector and the foreman, are held by the workmen and surrendered to the paymaster on being paid, so as to avoid disputes.

Piece-work vouchers are on pale blue paper. They are the same size as daily time slips, so that both can be conveniently brought together in bunches when compiling detailed labor costs, etc.

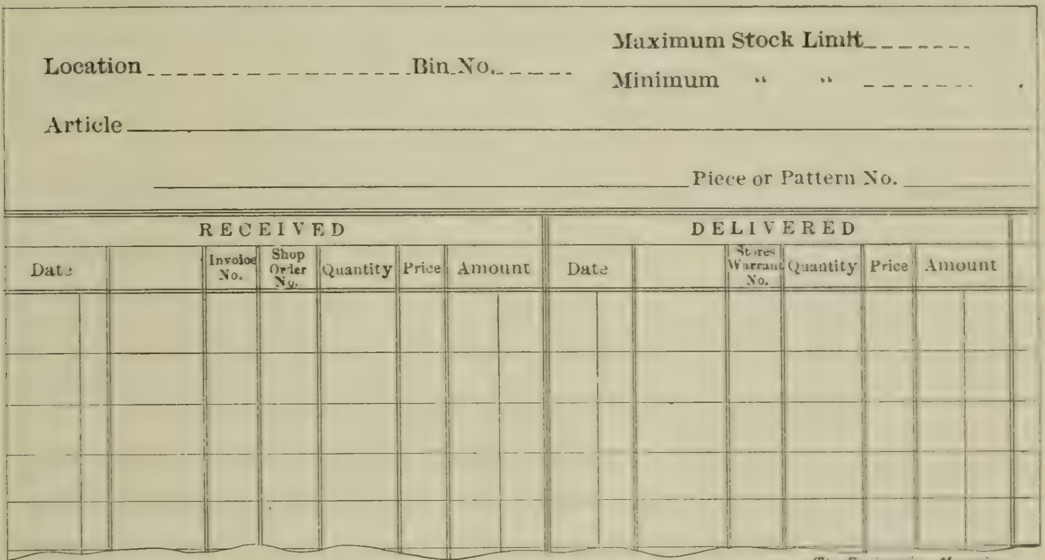
From the daily time slips a complete analysis of the weekly pay roll for use in the general books can be quickly obtained, all time charged to shop-order numbers being a direct charge to "Manufacturing" account, and the balance (which is comparatively small) being charged to such expense accounts as "Cost of Power," "Store-House Expense," "Department No. 1 Expense," "Department No. 2 Expense," etc. This is rendered more easy by having separate pay rolls for each department. At the foot of each pay roll its analysis is recorded. The agreement of such an analysis with the amount of the pay roll is a splendid check on the latter as to the accuracy of the number of hours recorded, and the rates, extensions, and footings.

All time of mechanical engineers and draftsmen is charged as far as possible into the different cost sheets, detailed time reports being turned in from the drafting rooms. This is very important in obtaining actual costs, especially in the case of work done on "Personal" shop orders, of which such time often constitutes a considerable item.

On the daily time slips will be noticed places for the recording of machine tolls. Rates of toll per hour have been established for the use of each of the machine tools in this works. The method by which these rates have been arrived at will be described a little later. The time during which the different machine tools are in use is filled in on these time slips by the department clerks, and is figured out just like the time of the workmen. From the time slips these amounts are also summarized and charged to the cost sheets. A summary is made at the end of each month of the total amount of these tolls so charged up in each productive department, forming the basis of an entry in the general journal which is debited to manufacturing and credited to the expense of the various productive departments.

All goods are purchased by the purchasing agent, who issues formal purchase orders bearing consecutive numbers. Purchase invoices go in the first place to the purchasing agent, who checks quantities from the receiving clerk's daily record of receipts book, prices and terms from the copy for the purchase order, and then marks off the latter. The invoices are here consecutively numbered, and passed on to the accounting department, where, after the extensions and footings are checked, they are entered up in the purchase journal.

In the case of goods purchased for stock, these invoices are as contra through the purchase journal debited to "Stores" account in the general ledger. They are then passed on to the store keeper, who debits in detail the various stores accounts in the stores ledger (see Form No. 8), notes on the invoice the stores-ledger folio, and returns the invoice to the accounting department to be filed away. In the case of goods purchased for use on specific shop orders or outside jobs, which do not go to the store house at all, the contra through the purchase journal is a debit to manufacturing account. These invoices are then passed on to the cost clerk, who debits in detail the various accounts in the cost ledger (see Form No. 9), and notes that he has done so on the invoices, after which these are filed away.



Maximum Stock Limit______

Location ______________ Bin No. _____ Minimum " " ______

Article ______________________________

______________________________ Piece or Pattern No. __________

RECEIVED							DELIVERED					
Date		Invoice No.	Shop Order No.	Quantity	Price	Amount	Date		Stores Warrant No.	Quantity	Price	Amount

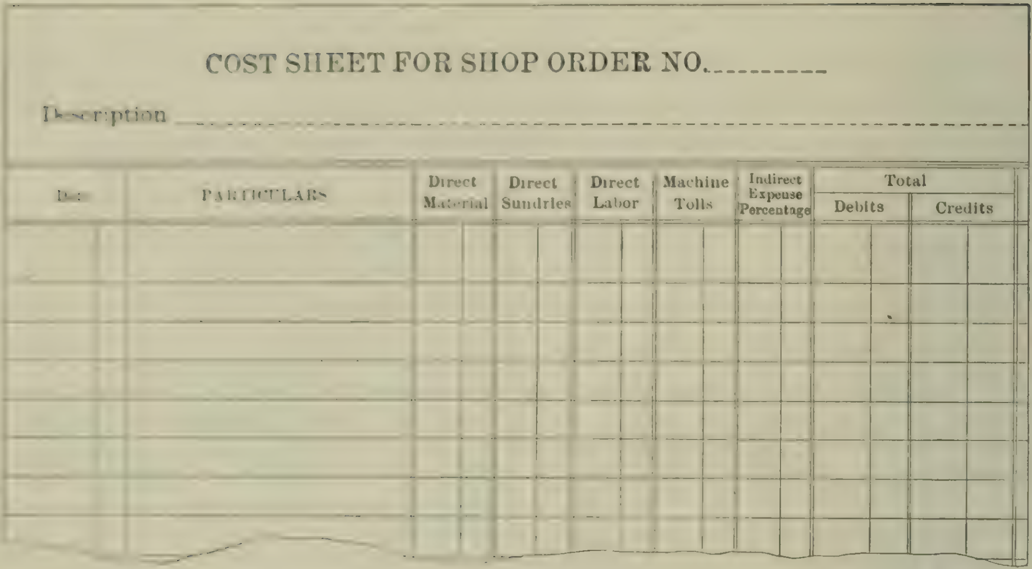
The Engineering Magazine

FORM 8. STORES LEDGER. REDUCED SIZE.

Nearly all goods are purchased either for stock or for use on some specific shop order or outside job. The exceptions are such as fuel and sundry supplies used in the power house which are charged to "Cost of Power," fodder charged to "Stable Expense," and sundry articles of the nature of process supplies used exclusively in certain other departments, which are charged to their expense accounts, etc.

Form No. 8 is a reduced illustration of the stores-ledger sheets which are bound in loose-leaf form, there being two inches of blank margin at the extreme left of each for binding purposes. At the top of the account is given the name or description of the article, with its piece or pattern number if it has one, the location and bin number, and maximum and minimum stores limits. Though not practicable in every case, both maximum and minimum stores limits are used as much as possible, the fixing or ignoring of these being left chiefly to the judgment of the store keeper.

In addition to debits to stores-ledger accounts being made from purchase invoices in the manner already described, they are also made from closed stock shop orders and from stores debit notes (see Form No. 7). On completion of a stock shop order, the quantity of articles delivered to the store house by the last department working on it is noted on the back of the order, and signed for by the store keeper



COST SHEET FOR SHOP ORDER NO.

Description

Date	PARTICULARS	Direct Material	Direct Sundries	Direct Labor	Machine Tolls	Indirect Expense Percentage	Total	
							Debits	Credits

The Engineering Magazine

FORM 9. COST SHEET. REDUCED SIZE.

or one of his assistants who receives them into the store. This quantity is debited to the account in the stores ledger, the price being afterwards obtained from the closed cost sheet made up by the cost clerk.

Stores debit notes are made out by department foremen whenever they return into store any surplus or scrap material left over from a shop order. These are consecutively numbered as received in the store house, priced, extended, debited in the stores ledgers, and then turned in to the accounting department. Here, after being credited in detail to the cost sheets, they are summarized at the end of each month, forming the basis of an entry in the general journal debiting Stores account and crediting Manufacturing account.

The store keeper delivers nothing out of the store house except in execution of stores warrants (see Form No. 6), which must be signed by the head of a department or other authorized person. These must state the shipping or shop-order number for which the goods are required, or for what other purpose, if they are not to be used on some specific shipping or shop order. As these stores warrants are executed, they are consecutively numbered by the store keeper, priced, extended, and quantities and amounts credited to the respective accounts in the stores ledgers. They are then passed on to the accounting department, to be charged up in detail in the cost ledgers, and then summarized at the end of the month, forming an entry in the general books debiting Manufacturing and other accounts and crediting Stores accounts.

Most stores warrants are executed on the same day as presented at the store house, though some have necessarily to wait a while, for obvious reasons. In such cases temporary notations of the quantities are made in pencil on the credit or delivered side of the account in the stores ledger, some distance below the last entry. When the goods are actually delivered, these pencil notations are obliterated and credited above in ink. Similar pencil notations are also made on the debit or receipts side of an account when goods are ordered, the purchase or shop order number and quantity being stated. When the goods are actually received these pencil notations are obliterated and debited above in ink.

The foregoing simple method of keeping track of the quantities of different articles wanted and on order has been found to work admirably. Being in loose-leaf form, these stores ledgers can be divided up into any convenient sections. A separate book is used for lumber, another for brass and copper, another for complete machines, etc. In some cases the rough castings and finished parts of certain machines are kept together in the same book.

While, as far as possible, all stores are centralized and kept in the store house, there are some which must necessarily, for the sake of convenience, be kept in the various departments. These are known as "Department Stores." As few as possible of such are kept. Their accounts are kept in the stores ledgers. As an example, the lumber and supplies used in the pattern shop are kept in that department. The department clerk, however, looks after them, and turns into the store house each day stores warrants for whatever have been used. Similar conditions exist in the carpenter's shop. In the blacksmith's shop certain kinds of iron must be kept. There are a few more of such cases in other departments. Said "Department Stores" are, however, surveyed periodically by the store keeper, any slight shortages being charged to the expense accounts of the departments.

The cost sheet used in the cost ledgers is illustrated by Form No. 9, which is in reduced size. These are in loose-leaf form, with two inches of blank margin at the left for binding purposes. Separate ledgers are reserved for the cost sheets of each of the three different classes of shop orders, viz, "Personal," "Stock," and "Plant" shop orders. At the top of each cost sheet is stated the shop-order number which it represents and a general description of the work. They are ruled in tabular form. The debits are written in black ink, and the credits in red ink.

In the "Direct Material" column is charged material from purchase invoices and also from stores warrants. In the "Direct Sundries" column are charged direct sundry charges other than material.

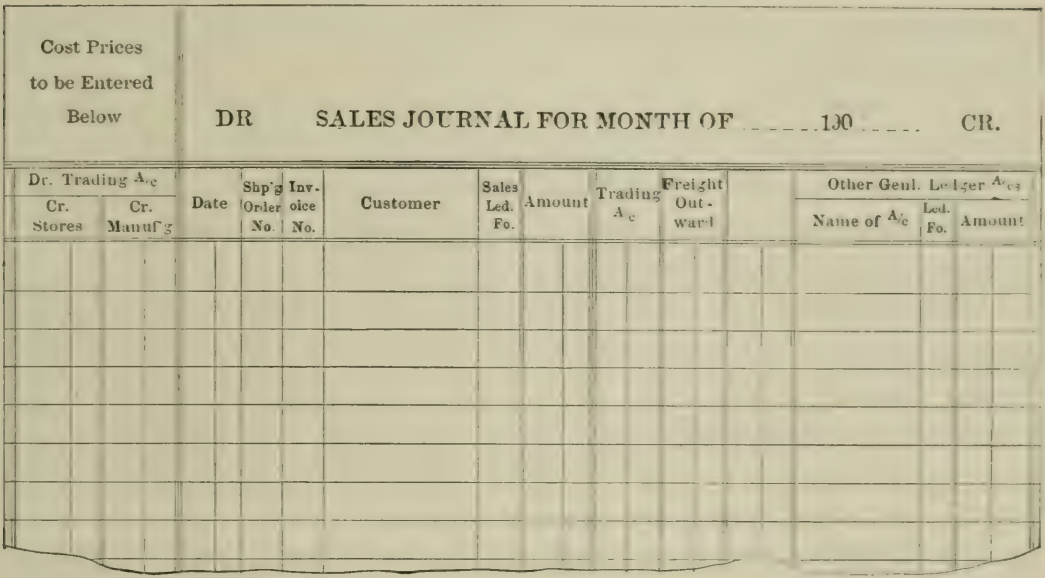
which may come from the purchase invoices, petty-cash vouchers, etc. In the "Direct Labor" column is charged direct labor from daily time slips and piece-work vouchers. In the "Machine Tolls" column are charged machine tolls from the daily time slips. The indirect manufacturing expenses (other than such portion as is embodied in the machine rates themselves) are charged as a percentage on the amount of direct labor and machine tolls combined. These percentages are added when a cost account is closed, and also to such cost accounts as are open at the end of each month. They are listed monthly under the various productive departments by the cost clerk, forming the basis of an entry in the general journal, which is debited to Manufacturing account and credited to the expense accounts of the various productive departments.

In fixing these percentages, each of the nine productive departments is treated separately and has a different rate of percentage. The other manufacturing expense account being at the end of each month closed out and distributed into the expense accounts of the productive departments, these departmental expense percentages are in this way made to cover the whole of the indirect expenses of the factory. The manner in which this is done will be explained later.

After being closed, the cost sheets are taken out of the cost ledgers and filed away in transfer cases. They are summarized and dealt with in the general books as follows:—

The costs of Personal orders are entered in the cost column headed "Manufacturing Account" at extreme left of sales journal (see Form No. 10). The costs of Stock orders closed during each month are summarized and form a debit to Stores account and credit to Manufacturing account, which is made by an entry in the general journal on the last day in the month. The costs of closed Plant orders are likewise summarized and journalized, forming debits to Plant accounts, Plant Repair or other expense accounts, and a credit to Manufacturing account.

The items charged in the first three columns of a cost sheet, viz, "Direct Material," "Direct Sundries" and "Direct Labor," constitute the "Prime Cost," which is also often spoken of as the "Direct" or "Flat" cost. When the machine tolls and the percentages to cover the other indirect manufacturing expenses have been added, the "Cost of Production" is obtained. This latter cost thus includes every expense, direct and indirect, till the goods are delivered at the factory door (or in the case of outside jobs, till the work has been completely erected and tested). It does not include the cost of selling, nor of



Cost Prices to be Entered Below

DR SALES JOURNAL FOR MONTH OF ......190...... CR.

Dr. Trading A/c		Date	Shp'g Order No.	Invoice No.	Customer	Sales Led. Fo.	Amount	Trading A/c	Freight Outward		Other Genl. Ledger A/cs		
Cr. Stores	Cr. Manuf'g										Name of A/c	Led. Fo.	Amount

The Engineering Magazine

FORM 10. SALES JOURNAL. REDUCED SIZE.

general office, administrative, and financial expenses. These latter are considered by the sales department, in fixing selling prices, as an additional percentage on the "Cost of Production" price of each article, thus bringing a figure, the difference between which and the selling price is net profit. This latter percentage is changed from time to time according to the amount of sales, and is very elastic, a large increase in the sales permitting of a considerable reduction in the percentage to be considered.

Referring to the two cost columns at the left of the sales journal, one headed "Stores" account and the other headed "Manufacturing" account (just mentioned), into which are entered the costs of all goods billed to customers—the footings of these are at the end of each month posted to the general ledger as a debit to Trading account and credit to Stores account and Manufacturing account. The costs entered in the Stores-account column are of such goods as are drawn out of store on stores warrants by the shipping clerk.

A separate cost ledger is kept for outside jobs. Most goods shipped to these are either drawn from the store house, or shipped direct by the merchants or manufacturers from whom they are purchased. Everything sent from the factory is shipped on consecutively numbered shipping orders, which emanate from the office of the superintendent of outside construction. The same form of shipping order is used as for goods shipped to customers, though a different series of numbers has been allotted. Of course, some goods have to be made and work done specially in the factory for specific outside jobs. In such cases shop orders are issued bearing the shipping-order number.

The depreciation of plant and equipment is pro-rated monthly in the general books. On the last day of each month a journal entry is made debiting the monthly amounts of depreciation to the different departmental and other expense accounts to which they belong, the contra being a credit to "Reserve for Depreciation" account.

Other expenses, such as water rates, factory taxes, insurance, etc., are pro-rated in a similar way at the end of each month, the amounts being debited to the departmental and other expense accounts, and credited to "Accrued Water Rates," "Accrued Factory Taxes," and "Accrued Insurance," etc. Against these accrued accounts actual debits for such charges are made from time to time.

In the general ledger is kept an account called "Cost of Power." To this are debited the wages of the engineer and fireman who attend to the power plant, and of the millwright and oilers who attend to the equipment for transmission of power throughout the works; also all other expenses connected with the generation and distribution of power, such as fuel, oil, and sundry supplies consumed, maintenance, depreciation, and insurance of this plant and equipment, etc. At the end of each month a report is made by one of the mechanical engineers to the accounting department of the net amount of power estimated to have been consumed in each of the productive departments. This, computed on the basis of 1¾ cents per horse-power hour (which past experience shows to be approximately the cost of generating and transmitting power in this works) gives the data for a general journal entry debiting the expense accounts of the productive departments, and crediting "Cost of Power" account. So nearly accurate does this work out, that at the end of each month the debit or credit balance of the later account is invariably trivial.

The matter of machine rates, which has been briefly referred to in the foregoing, will now be more fully described.

Throughout the works there are about five hundred machine tools, each bearing a different number, and for the use of which separate rates of toll per hour have been established. The four factors entering into the composition of these rates are:—power consumed by the machine, maintenance of the machine, depreciation of the machine, and department expense (equivalent to interest on the amount of capital invested in the machine). The following is an illustration of the way in which they are computed. Take for instance a planer valued at $4,000.00, consuming on an average while engaged on the medium class of work for which it is used, 9 horse-power per hour, and assuming it to be in operation 10 hours per day for 300 days in the year:—

interest on the amount of capital invested in the
5 per cent. per annum repairs on $4,000.00 = 200.00
6 per cent. per annum depreciation on $4,000.00 = 240.00
An amount of indirect departmental expense, equivalent to
27,000 horse-power hours at 1¾ cents per hour = $472.50
machine (*i.e.*, 6 per cent. per annum on $4,000.00) = 240.00

Making a total for the year of $1,152.50
$1,152.50 divided by 3,000 hours brings what is practically 38½ cents per hour as the rate of toll.

These tolls are charged into the cost accounts from the workmen's daily time slips, as already explained. In the case of a few machines which are only used periodically, and then for so short a time as to render the recording of it impracticable (such as cranes, grindstones, shears, etc.), their machine tolls are ignored altogether.

In the cost accounts of many factories the conditions are not such as to render machine rates necessary, the incidence between the different departmental expense accounts alone and the departmental pay rolls forming the basis of distribution. This is all right in connection with a department in which the machines are all of one kind and size; but in an engineering works these conditions do not usually prevail to any great extent, large machines and small machines working side by side in many departments together with mechanics working by hand alone. In such cases, the percentages figured as the ratios which the departmental expense accounts for a given period bear to the departmental pay rolls must be very misleading.

In the general ledger an expense account is kept with each of the nine productive departments. These are known as "Department No. 1 Expense Account," "Department No. 2 Expense Account," and so on. To each of these is charged all the overhead or indirect burden of the department, consisting of wages of foreman, assistant foreman, department clerks, general laborers, and any other time which cannot be allocated to any specific shop order. Also all sundry process supplies and other articles which cannot be directly allocated, such as oil, waste, emery wheels, sand paper, fuel, etc.; cost of power consumed, depreciation of machinery and tools and current repairs to same, and any other indirect charges incurred in operation.

In addition to the expense account of these productive departments, there are the other manufacturing expense accounts, common to some extent to the whole factory, such as wages of superintendent and his assistant, clerks, gate keepers, watchmen, etc., store-house expenses, yard expense, general pattern expense, general tool expense, repairs to building, depreciation of building, etc. These are distributed monthly into the expense accounts of the productive departments, though necessarily somewhat arbitrarily, yet in what seems to be the most equitable manner, in view of the way in which they will ultimately be charged into the cost accounts. For instance, the wages of the superintendent and his assistants are divided up in proportion to the number of hands in each of the departments; repairs and depreciation of buildings to some extent in proportion to the amount of floor space occupied by each department; general pattern expense into the expense accounts only of such departments as work on castings; general tool expense in proportion to the amount of general tools used by each department, and so on. By treating this latter group of accounts in this way, a single rate of percentage has been obtained for each of the productive departments, covering not only the indirect expenses of the department itself, but also the other general expense of manufacture. This considerably simplifies matters, especially in connection with the cost-clerk's work, several additional percentages being avoided.

As there are nine productive departments, there are nine different rates of percentages. Usually these are not changed more than once a year. The debit or credit balances of these accounts, as shown by the general-ledger trial balance at the end of each month, which are generally small, indicate whether these expenses are being distributed as fast as incurred or not. If the balance is on the debit side of the ledger, the rate of percentage in use would appear too low, and if on the credit side, too high. However, there may be special or extraordinary circumstances increasing some departmental expense accounts in some months which do not necessarily impel a change in the departmental percentage rate, such as a strike of workmen, a dull period in which many of the machine tools are idle, an unusually heavy amount of repairs, etc. Said expense accounts are an index to these and other similar conditions, and are carefully analyzed by the accounting department every month. The question of departmental repairs is considered somewhat on a percentage basis, and so viewed, as shown in the fixing of machine rates; for to be guided altogether by the cost of actual repairs would be misleading, there being practically no repairs in some departments for several months, after which they become periodically heavy.

There is an extra percentage added to the cost sheets of outside jobs to cover the indirect outside expense, such as the salary of the superintendent of construction and his assistant, and the uncharged time and expenses of such of the outside men as are occasionally idle, etc. This is a percentage on the amount of direct outside labor.

Years ago, owing to ideas of false economy and other causes, chaotic conditions prevailed in this works. There was very little system at all. No records were kept of stores on hand, the store keeper trusting chiefly to his memory and observation. Consequently great quantities of valuable stores were overlooked and kept till they became obsolete, others being purchased or made as required. Workmen helped themselves to a great extent to anything they required, there being no stores warrants or similar documents. Foremen made whatever they considered necessary, and in just such quantities as they fancied, written shop orders being seldom issued, and even then to a great extent ignored. When standard machines had to be built, there would be excessive quantities of some parts on hand and none at all of others, thus causing great delay and expense. No time slips were used, and there was little attempt made at cost keeping, the prime cost being occasionally taken, and an amount added to cover the indirect manufacturing expenses, sometimes on the rate-per-hour and sometimes on the percentage-on-wages plan; but this partook more of the nature of an estimate or guess than of an actual cost. The piece workers were paid whatever their foremen reported was due to them, without further verification. The annual inventory was a perfunctory affair, the value in many cases having to be guessed at, making the revenue account and balance sheet very unreliable.

Now all this has been changed. Great economy is effected by having nothing made except in execution of written shop orders. Confusion and errors have been reduced to a minimum. The system of keeping track of and following up shop orders in progress by means of the card frames in the superintendent's office tends greatly to expedite delivery. The store keeper can immediately tell from the stores ledger just what is on hand and the actual cost of it. Any variations in the cost of articles from time to time, being clearly shown up here, can be quickly investigated. Actual costs of everything made are promptly obtained, the value of which information cannot be over-appreciated, especially in the case of job or personal worth wherein the selling price is often governed altogether by the cost. Moreover, the cost sheets being in analytical form, the causes of variations in costs are readily observed. The cost clerks can also quickly compile detailed labor costs, and make comparisons between prices paid at day-work rates and piece-work rates, facilitating the creation and revision of the latter.

In the sales journal, the actual cost of everything billed being shown on the same line as the amount charged to the customer, the profit on each invoice is at once apparent, and any loss quickly investigated.

A pro-forma revenue account and balance sheet is made up at the end of each month from the general-ledger trial balance without taking inventory, the accuracy and completeness of the cost system and the way in which it is perfectly controlled by the general ledger rendering this possible. The assets shown to the debit of Stores account and Manufacturing account, the former representing the value of the stores on hand, and the latter the value of work in progress, both in the factory and outside, are verified by their agreement with the aggregate of the debit balances taken from the stores ledgers and the cost ledgers, which these two general ledgers accounts respectively control.

An actual inventory is taken at the end of each fiscal year by closing down the works for two days only. So accurate, however, are the cost accounts and the stores accounts, that this annual inventory might almost be dispensed with altogether, the quantities on hand as per the stores-ledger accounts being checked from time to time with actual counts made of the articles themselves.

The expense of operating this system, while considerable, is well offset by the benefits obtained. There are in the neighborhood of ten-thousand separate accounts in the stores ledgers, most of which are active; these are kept up by four clerks, receiving on an average not more than $1.50 per day each, who also do all other clerical work in the store-keeper's office. Considering that there are at times upwards of $500,000 worth of stores on hand, it is well worth such an expenditure for clerical help if only to keep track of the quantities. The cost ledgers are kept up with even a less expenditure for clerical help than the stores ledgers.

With necessary changes and modifications, this system can be adapted to suit the requirements of most engineering works, and where the business is too small to warrant the expense of a complete system, or other conditions render it impracticable, parts of it may be advantageously installed. With further changes to suit special conditions, it can also be used in many other factories.

TRAVELING CANTILEVER AND LOCOMOTIVE CRANES, NEWPORT NEWS SHIPBUILDING & DRYDOCK CO.

SHIPYARD CRANES AND THEIR FUNCTIONS IN MARINE CONSTRUCTION.

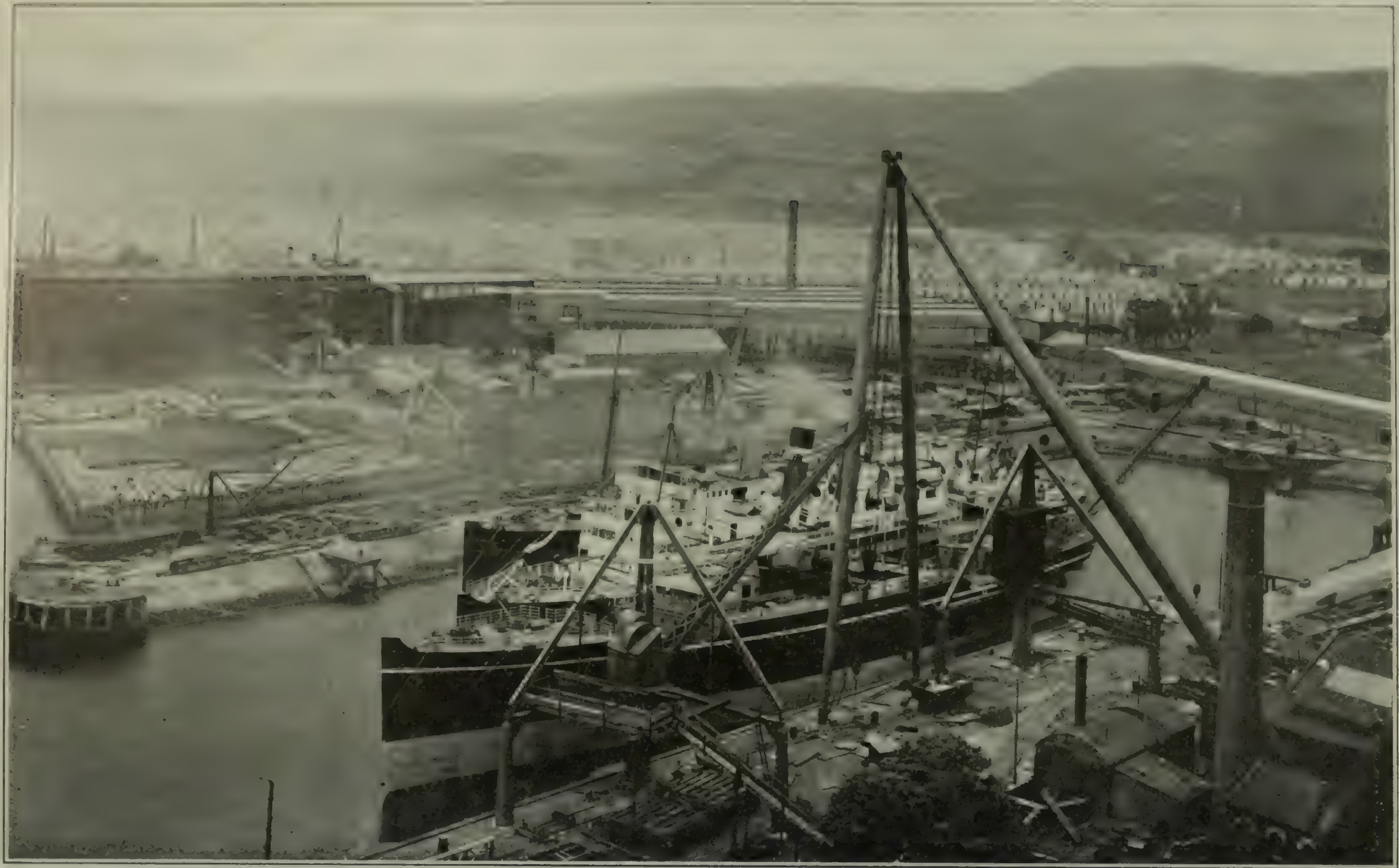
By Jos. S. Shultz, U. S. N.

Lieutenant Shultz's discussion does not exclude the mechanical features of the installations he describes, but makes most prominent the broader effect they have on the economy of ship-building. While his review is addressed primarily to American practice, some of the most important and modern examples of British machinery in the same class are presented for comparison in the illustrations.—The Editors.

IF, as so many people assert, it is still true that American shipyards cannot compete with others in point of cost in the building of modern maritime craft, this condition is not due to the methods of operation nor the machinery equipment now employed in the large yards on the Atlantic, the Great Lakes and the Pacific.

That such superior machinery is now available for the building of American ships is not, however, the results of a demand caused by a decided increase in domestic ship construction; but rather has the marked attention devoted recently to this industry been directly brought about by a realization that in this field could be successfully applied the methods and the devices perfected in the development of those industries so characteristically American, i. e., the manufacture of steel into structural shapes and the handling and transportation of ores and fuel.

It has been but a few years since every large steamship plying between America and foreign ports, when disabled or in need of repairs, would be put out of commission and towed back to the yard



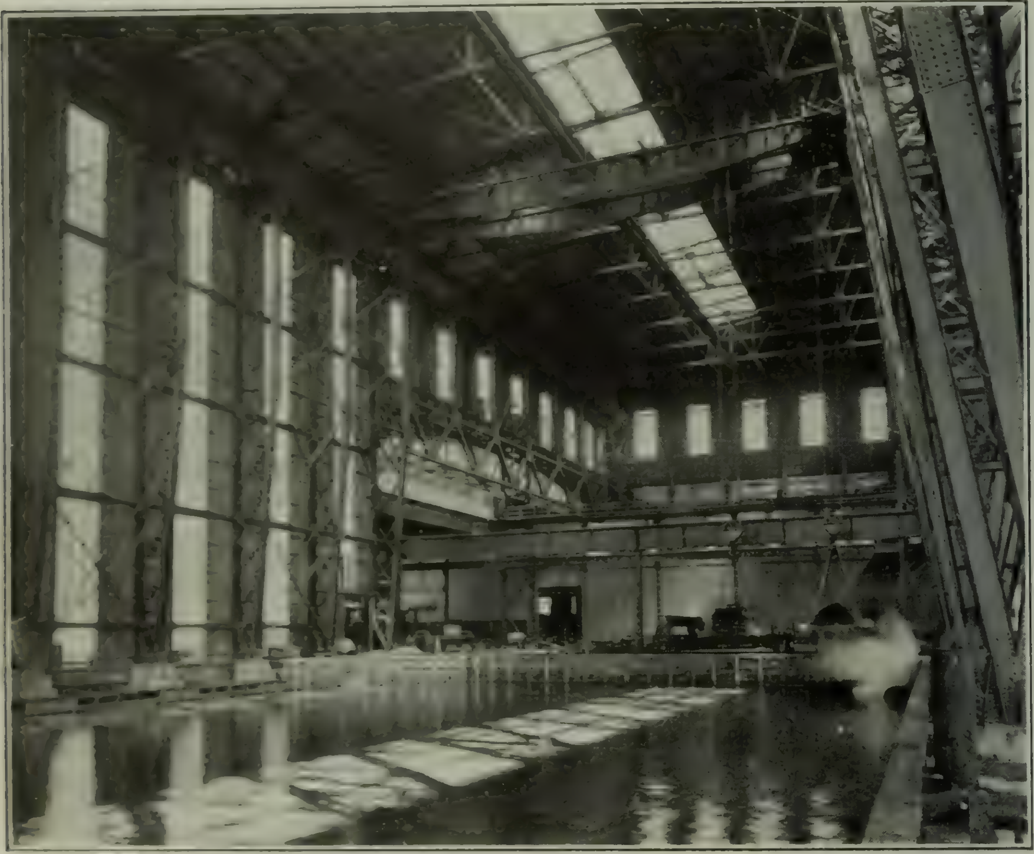
SHEAR LEGS AND CRANES, SHIPYARDS OF WILLIAM DENNY & BROTHERS, DUMBARTON.

The shear legs in the middle are of 110-tons capacity; the cranes on each side (supported on pillars so as to span high and broad ships) are 20-tons. The three vessels lying in the dock are all turbines—outside, the "Loongana," Union Steamship Co. of New Zealand; middle, the Midland Railway's cross-channel steamer "Londonderry"; nearest, the British Steam Navigation Co.'s "Lhasa."

where it had been built for whatever work was necessary; and even at late as July of last year the giant Cunard freighter "Slavonia" was placed in a naval drydock at New York simply because there was no commercial shipyard in the United States where the hull could be cleaned and painted without a delay of an indefinite length of time. The fact is that, as the result of years of experience, the building of wooden ships had advanced to such a degree of perfection in America that vessels of that class constructed in home yards were without a peer in point of both cost and general merit; but when the change from wood to steel hulls was made there were other and more absorbing lines of industry to which the American workmen and capitalists were directing their attention—the result being that ship construction was held in abeyance until, in the advancement of the former, means were developed which it was seen could be very advantageously employed in the building and repairing of steel ships.

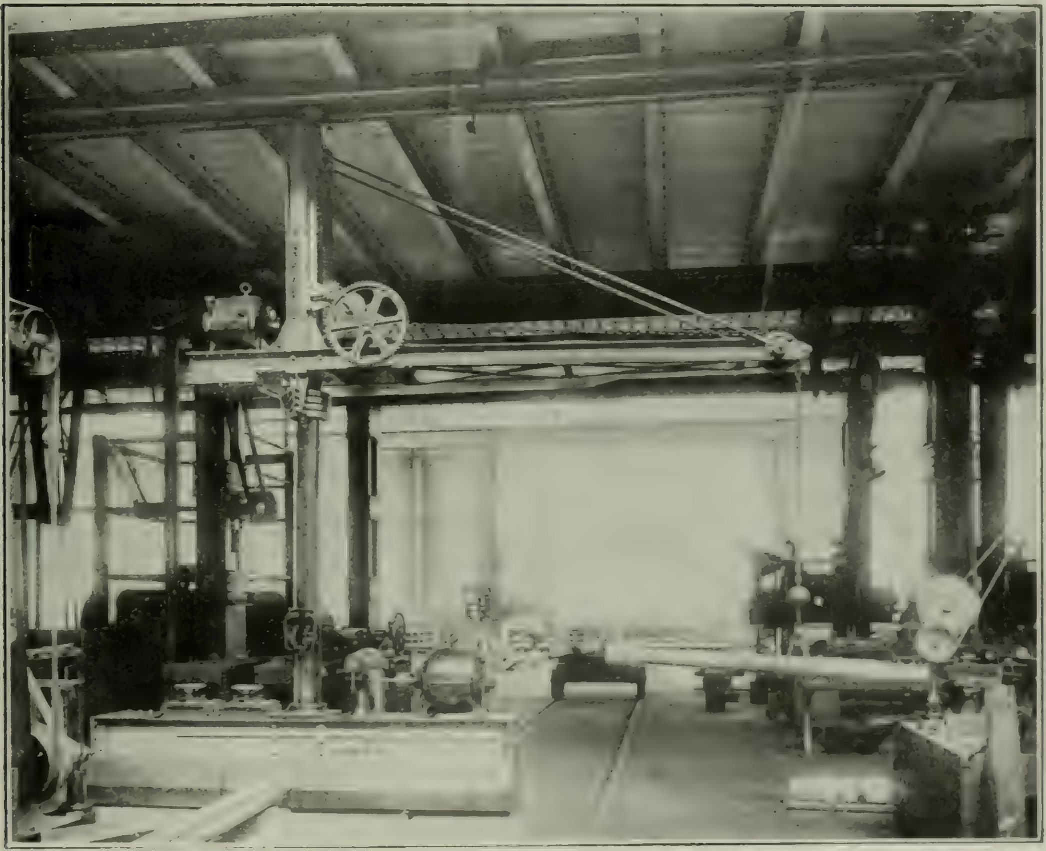
A shipyard which is designed for both repair and construction work (and every successful one must be, in order to keep in continuous and economical operation during intervals when no new craft are being built, or *vice versa*), should have more or less completely equipped the following departments:—First, repair and manufacturing shops, where all of the material necessary for the vessel and its machinery is made and put together. Second, storehouses for supplies and equipage, where the raw materials, spare parts, and other ships' requisites are held ready for immediate issue. Third, wharves, quay walls, and building ways, where berthing space for craft under repair and facilities for initial construction are provided. And fourth, drydocks (floating or graving), where opportunity is afforded for ready access to the hull and submerged mechanical parts. But expeditious and economical work in connection with every one of the above can be carried on only with a complete and modern installation of cranes; and therefore this fifth division, though by no means the most important, is at least the essential link which connects the otherwise isolated portions and binds them into an interdependent, smooth-working, composite plant.

In those early American yards from which so many staunch merchantmen were launched, and in the present ones where sailing craft are exclusively built, a jib was rigged to the mast of one of the vessels or to a fixed strut on shore, and this furnished all of the required means for transfering and handling material. And even in many of our present modern plants may be found a stationary wharf crane of the jib type, unloading coal or pig-iron from a barge, or a revolving pillar crane handling the moulds of a foundry—but these are the relics of the initial equipment, which soon proved wholly inadequate for the work demanded of a transportation agent in any plant bidding for the care and construction of modern steam- and war-ships.



ONE-HUNDRED-TON TRAVELING CRANE OVER THE WET DOCK, NEW YORK SHIPBUILDING CO., CAMDEN, N. J.
Built by William Sellers Co., Phila., Pa.

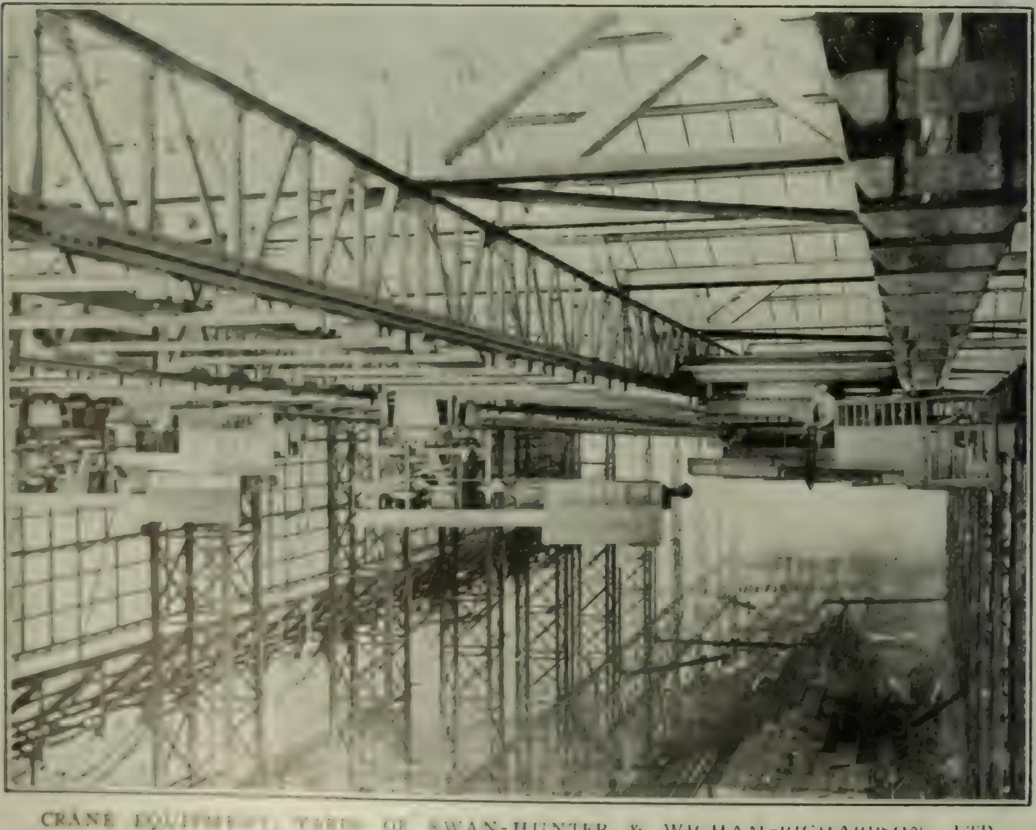
The designer of the crane machinery of a modern ship-building yard containing the above noted departments has a most varied assortment of conditions to meet; but fortunately his otherwise arduous task is greatly lightened by the fact that not all of his designs need be original to answer fully the requirements of the service to which they will be placed. In lieu of the clumsy pillar cranes which stood in the center of the iron and steel foundry, and from that position served but a very small part of the floor, there is substituted an electric bridge traveling crane with a movable trolley—an exact counterpart of the one used in the structural-steel mill—which covers every square foot of the floor area, takes up no valuable space, and is operated by one man, with a consumption of power only when actually in motion, thereby saving the continuous steam or hydraulic power needed for the pillar cranes, and the wages of the individual operators. In the brass foundry and the coppersmith shop, where the material is in pieces of comparatively light weight, 5- or 10-ton electric cranes of the bridge type, but operated by hand-ropes from the floor, tend towards a still further reduction in the expense of handling moulds and finished castings. And the manufacturer of the transportation equipment for the structural-steel plant furnishes directly from his stock the cranes necessary for the boiler and machine shop in the shipyard. A large traveling crane of this kind, with a capacity of 50 or 60 tons, is located on tracks only a short distance above the floor and moves with absolute precision and no loss of time the large steam cylinder or the assembled engine, the propellors or the immense driving shafts, the boilers or the condensing outfits; and above this, with half the span, fast-moving and similar but smaller cranes serve the individual lathes, drill-presses, etc. Thus does the projector of a ship-building plant have for his immediate use, and at a cost far below that of a specially designed apparatus, the equipment which has been perfected and improved for the making of structural steel; and he uses these same cranes in his boat shops, for punching, shearing, and riveting the hull, deck, and bulkhead plates, and for forging the beams, angles, and channels in the



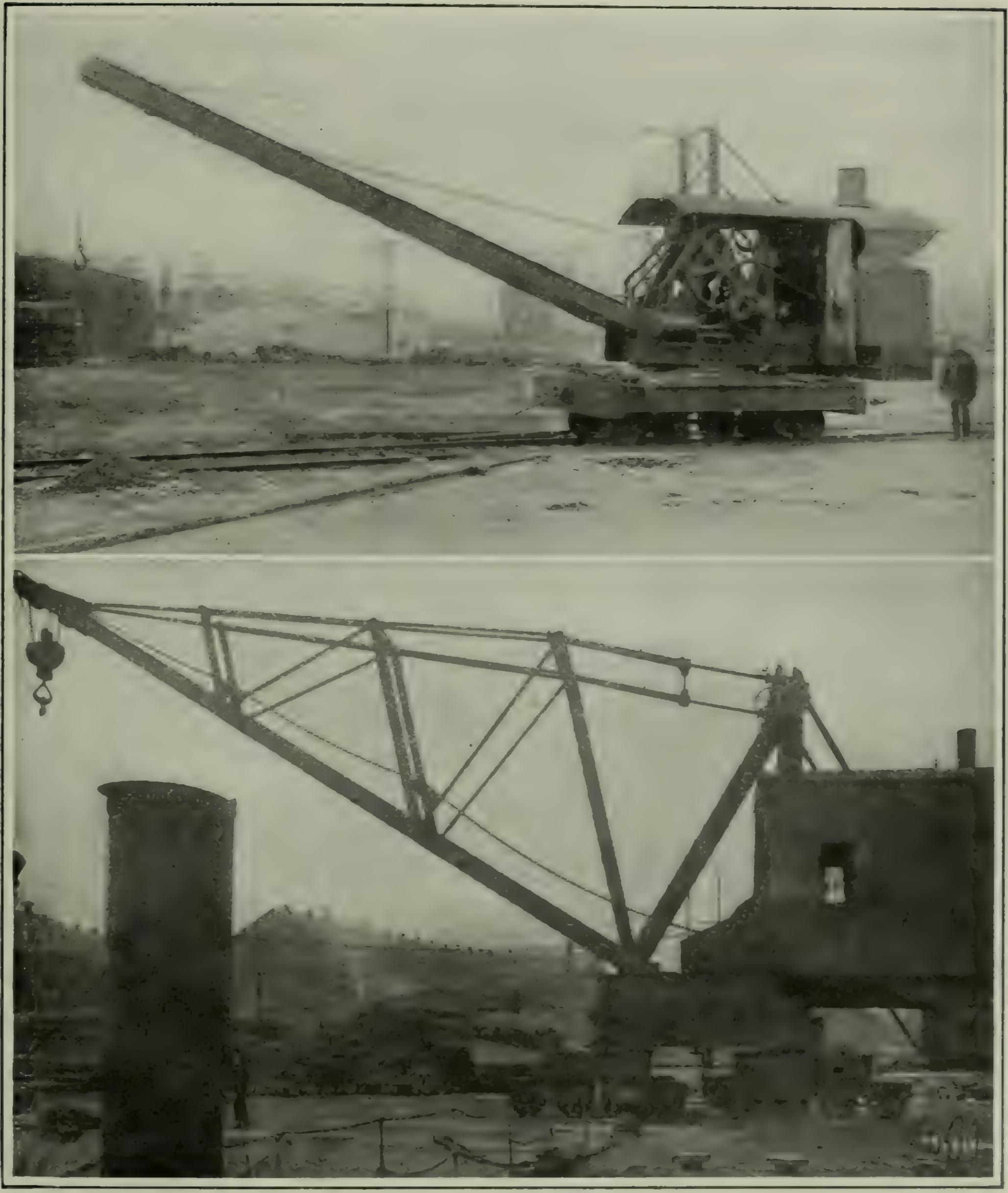
ELECTRIC SINGLE-RAIL TRAVELING JIB CRANE, $1\frac{1}{2}$-TONS CAPACITY.

Radius 12½ ft., height to top of post 18½ ft.; travels on a rail flush with floor. Jessop & Appleby Bros., Ltd., Leicester and London.

GANTRY CRANE LONG USED IN YARDS OF MESSRS. ALEX. STEPHENS & SONS, GOVAN. Erected 33 years ago, and only lately displaced. 60 ft. above keel blocks, 70 ft. span; lifting power 50 tons—ample in its day for the size of steamers then built. Replacement began about 15 years ago. By its use boilers, machinery, and sometimes even coal were shipped before launching.



CRANE EQUIPMENT, YARDS OF SWAN-HUNTER & WIGHAM-RICHARDSON, LTD. There are two berths, each equipped with five cranes.

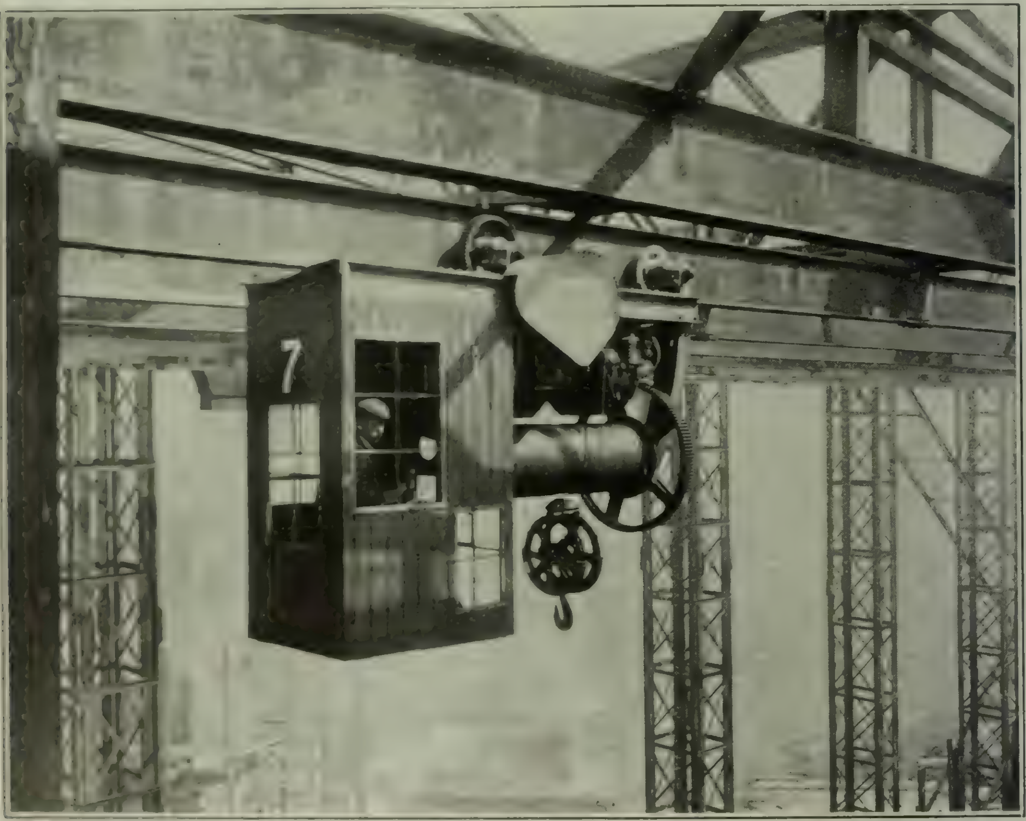


LOCOMOTIVE AND TRAVELING DOCK CRANES, NEW YORK NAVY YARD.

The upper figure shows a 15-ton locomotive crane; the lower one is a 40-ton traveling crane, revolving on the turntable supported on the double truck shown.
William Sellers Co., Phila.

frames; and in his storehouses, where he also has installed the hand hoists and telpherage systems employed in the rolling-mill and blast-furnace department of the steel plant. And outside, on standard-gauge railroad tracks, locomotive cranes—duplicates of those in the yards of structural mills—unload the material and transport it from point to point as required.

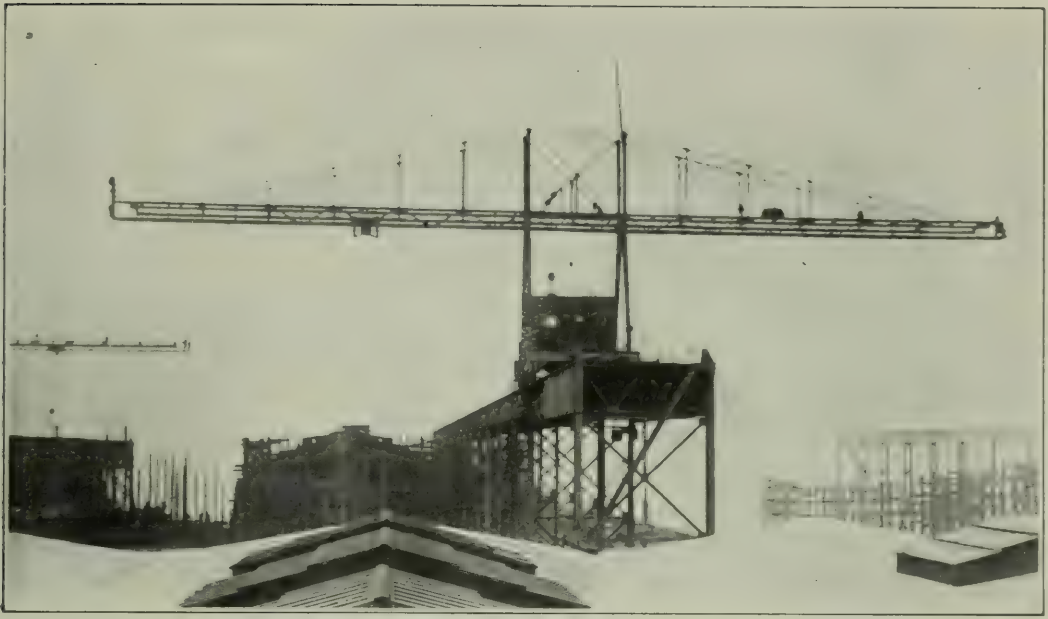
Here, however, the analogous use of cranes in the two industries ceases; for it was demonstrated when the keel of the first large steel vessel was laid in the United States that economical and rapid construction could be made only with the aid of a device which would serve every part of the vessel building, from bow to stern, and from port side to starboard. But this problem proved comparatively easy of solution, for with the ideas gotten from observation upon the tramways used in transporting ores and fuel, there was soon perfected the cantilever ship crane, which, when installed on a framework of sufficient height to clear the topmost part of the completed vessel and of a length corresponding to its over-all dimension, transfers and installs most efficiently every piece of material entering into the actual shell of the vessel. This type is usually built for a capacity of 5 tons



OVERHEAD TROLLEY HOIST, SHIPYARDS OF WM. DOXFORD & SONS, LTD., SUNDERLAND.
Lifts 3 tons at speed of 150 ft. per minute; travels 400 ft. per minute.

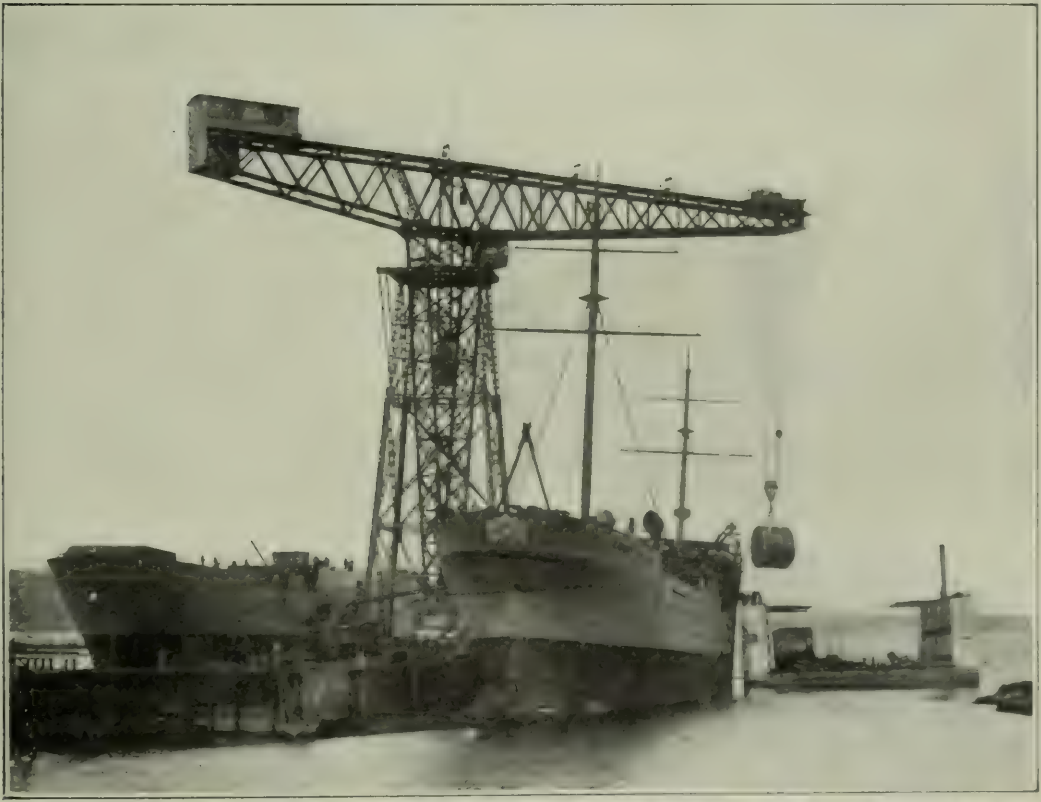
at the extreme end, and the longest one is 360 feet from one cantilever extremity to the other. The load is counterbalanced throughout its movement; the speed of vertical hoist varies from 350 to 700 feet per minute, of horizontal trolley travel from 400 to 800 feet, and the entire crane moves along the trestle at 400 to 700 feet per minute, depending upon the load and the wind pressure prevailing.

Only the stationary portions of the hull proper, however, are placed in position while the vessel is on the building ways—the engines, boilers, dynamos, and other machinery and the armor plate on war craft are put aboard after launching, when moored alongside the



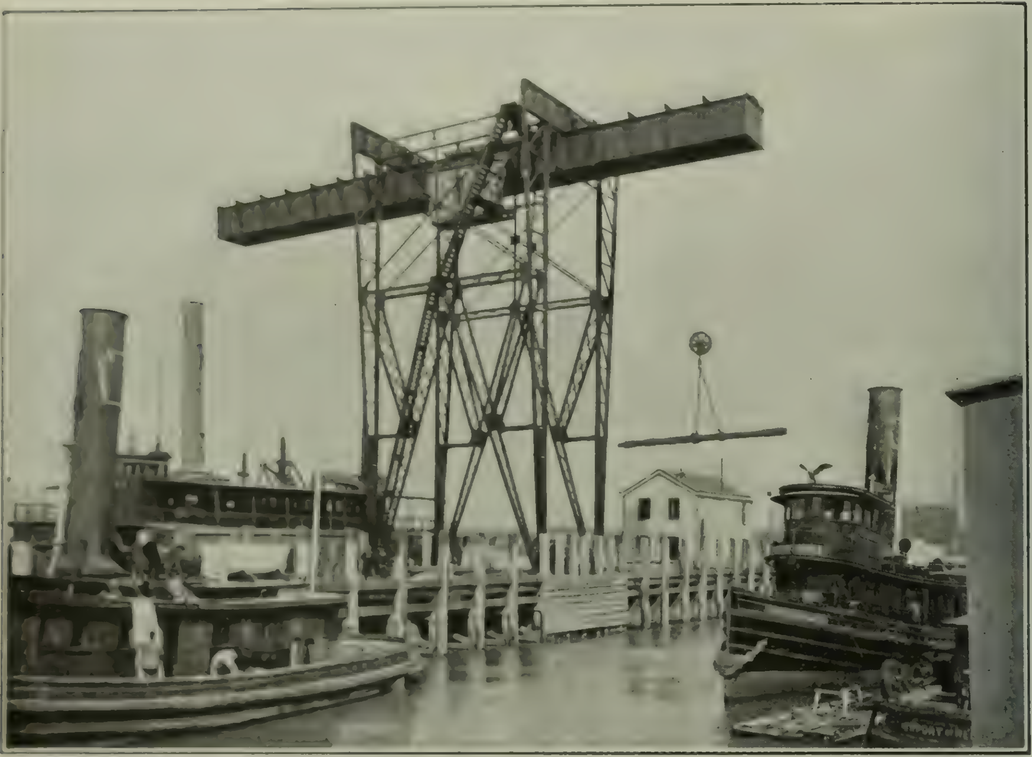
LARGE TRAVELING CANTILEVER CRANE ON ELEVATED RAILWAY, NEWPORT NEWS SHIPBUILDING & DRYDOCK CO.

Three partially completed vessels are on the building ways. Crane built by Brown Hoisting Machinery Co.



GIANT CRANE OF "HAMMER" TYPE, 150-TONS CAPACITY, ELECTRIC-DRIVEN.

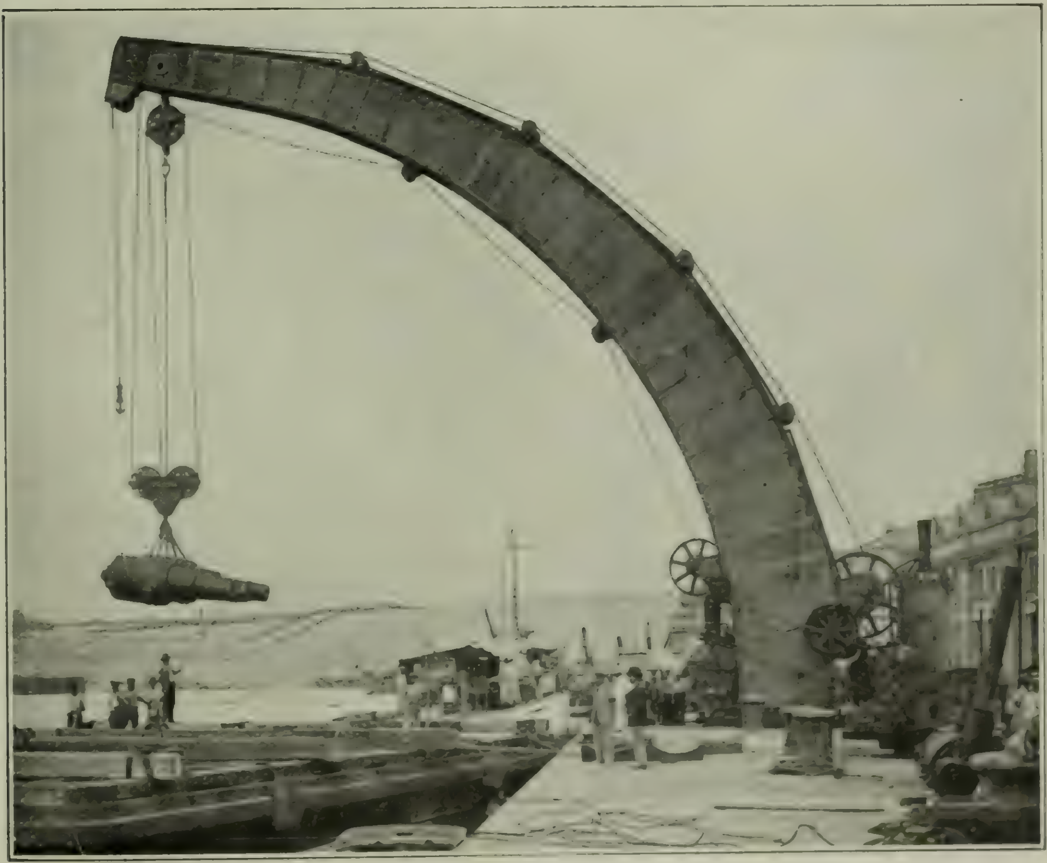
Height 150 ft. Large radius 135 ft., small radius 78 ft.; lifts 150 tons at 3 1-3 ft. per minute at 60 ft., 50 tons at 125 ft.; slews 360 degrees in 10 minutes; weight 450 tons. Later type has crabs on both arms, acting mutually as counterweights. Benrath Engineering Co., Benrath and London. Supplied to Howaldt Works, Kiel, to William Beardmore & Co., Ltd., Vickers, Sons & Maxim, Ltd., etc.



FORTY-TON FIXED GANTRY WHARF CRANE, PENNSYLVANIA RAILROAD, HOBOKEN, N. J.
Built by William Sellers Co., Phila.

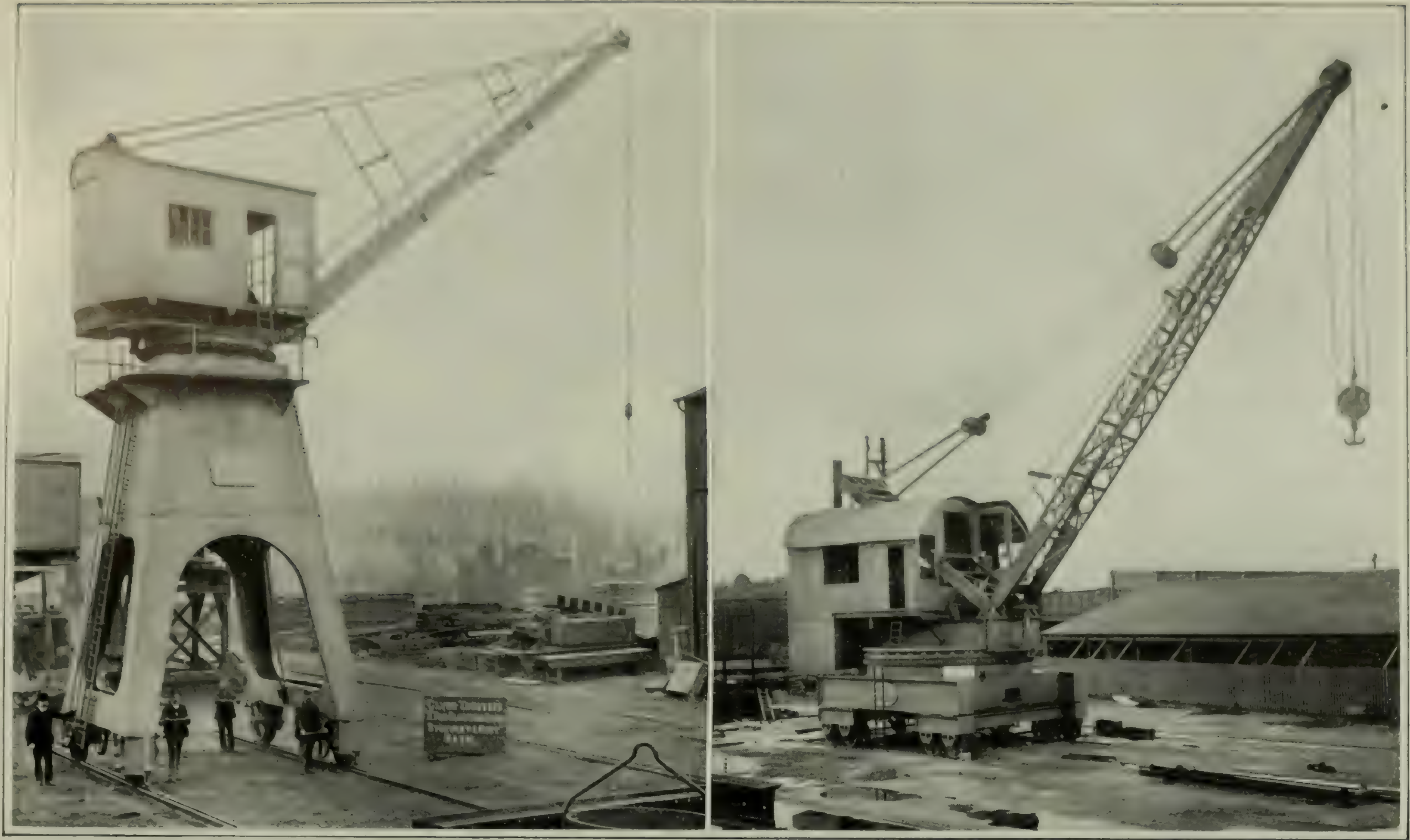
wharf or while in drydock; and the repairs to all vessels are made only under these latter circumstances. Consequently there are two other classes of cranes which are requisite for the complete operation of the shipyard plant, and which are peculiar alone to maritime construction work. These are the ponderous dock cranes (traveling and stationary), and those of the floating class; and inasmuch as shipbuilding in America has but recently assumed its present businesslike proportions, there have been developed no general types for cranes in these classes. The resulting mechanisms are therefore wholly diverse in character, and are merely expositions for the ideas of the individual naval experts. All, however, are more or less intricate in design and make-up, and therefore the initial cost of this special machinery, useful as it is for only a very restricted field, would prohibit its manufacture were it not for the fact that the builders of the cranes, tramways, and conveying machinery for general use can apply their methods and employ their workmen on these new and unusual constructions to advantage and with practical commercial economy.

Dock cranes of the traveling type move on tracks built along the berthing wharves and around the drydocks, and all have a very wide gauge, which varies from 18 to 60 feet. One of the most useful of these structures is of the cantilever jib class, mounted upon a heavy, pivoted base, revolved through a complete circle by means of a train of gears, one 8 inches in diameter and the other 20 feet. The framework supporting the revolving superstructure rests upon two separate trucks, each containing eight heavy cast-iron wheels; and, in order to facilitate movement around the short-radius curves at the head of the docks and in the angles of the wharves, the truck supports are also made movable. The jib is a cantilever, inclined at an angle of about 40 degrees to the horizontal, with a heavy A-frame lower chord connected to the top chord through a system of Warren truss bracing. The capacity of this crane is 40 tons, and the load is carried on a heavy chain supporting the large pulley block, the center of which is 80 feet from the center of the crane base, thus giving an opportunity for removing material from all parts of the largest vessel when in drydock. The load is balanced by placing the boilers and engines at the opposite side in an overhanging structure. There is also a small 10-ton auxiliary rapid-motion hoist at the extreme end of the jib for handling small loads more quickly than by the main racking device. The most interesing part of the mechanism, however, is the two large screw shafts, connected at the inner end



FIFTY-TON STEAM CRANE, FAIRBAIRN TYPE, GOVERNMENT DOCKYARD, MALTA.

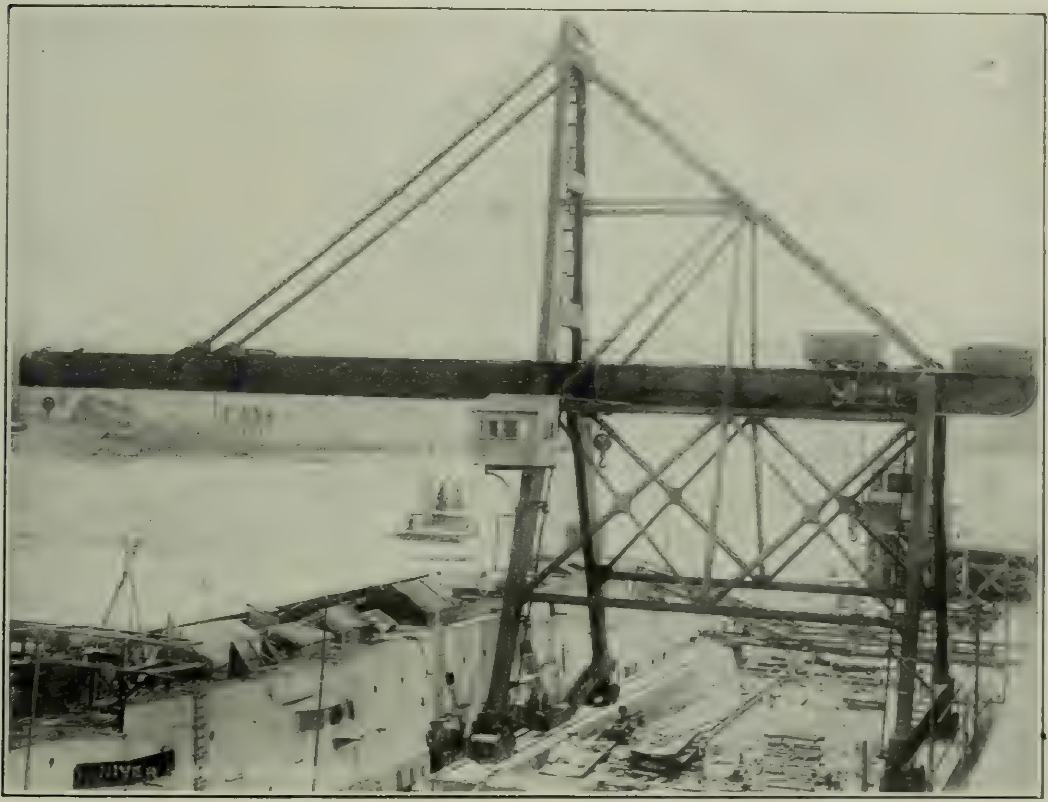
Height to center of jib top pulley 65 ft.; lifts 50 tons at 60-ft. radius; two pairs of engines, one for hoisting and one for slewing. Built by Cowans, Sheldon & Co., Carlisle.



PORTABLE CRANES FOR DOCK AND SHIPYARD USE.

On the left, a 3-ton electric dock-side crane, built by Stothert & Pitt, Ltd., Bath, for the Clyde Trustees. On the right- a 30-ton steam traveling crane, by Cowans, Sheldon & Co., Ltd., Carlisle, for construction work in H. M. dockyards.

to the top chord, by which the boom is raised and lowered through a distance of 8 feet with the absolute precision necessary when setting heavy engine parts or armor plate. This crane is used very extensively in government plants, and in point of utility for this phase of naval work is unsurpassed. It is shown on page 65.

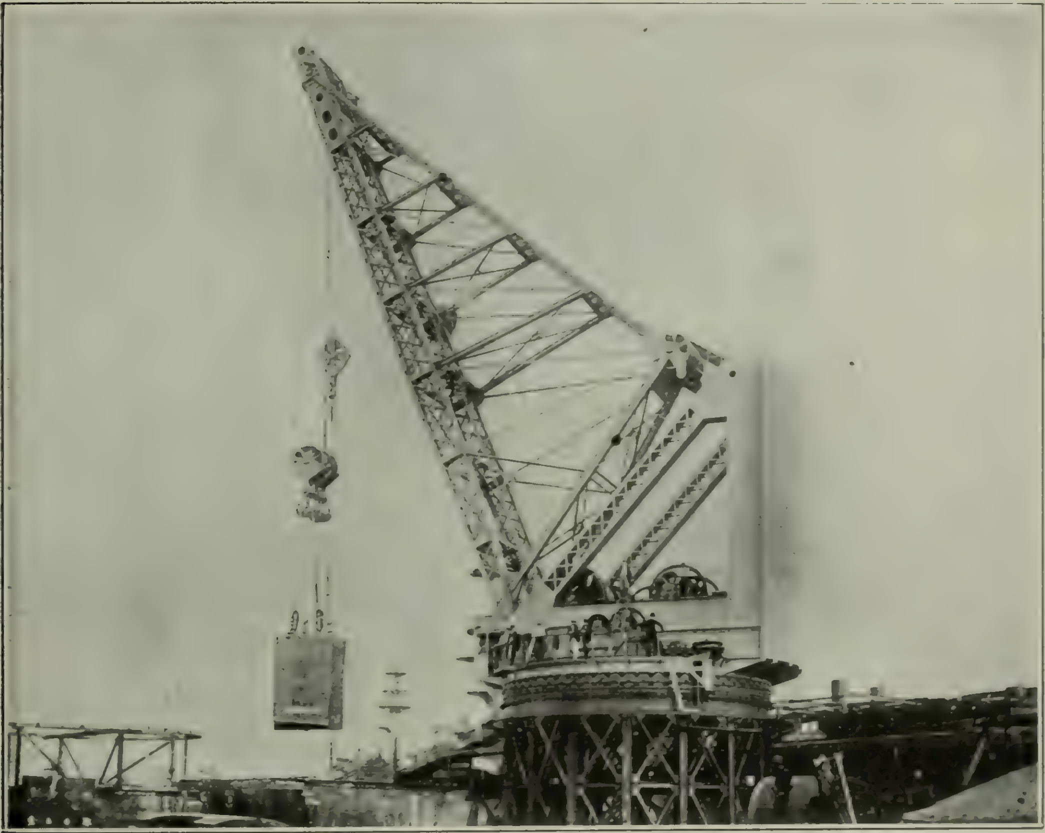


FOLDING-JIB GANTRY DOCK CRANE, TRAVELING TYPE, FORE RIVER SHIP & ENGINE BUILDING CO.

75 tons capacity. Built by Wellman-Seaver-Morgan Co.

Another extremely interesting crane of this class is one of 75 gross-tons capacity, shown above, constructed so as to combine the characteristics of the above dock cranes and also the peculiar features and advantages of those of the floating type. Essentially this consists of a massive A-frame on the dock side, 105 feet high, and a similar one, but lower, on the inshore side, which support the simple plate-girder beam for the shore travel of the trolleys, and the movable overhanging cantilever arm for the trolley runways when serving a vessel lying alongside the wharf. The four ends of these A-frames separately rest upon a truck containing four heavy double-flanged wheels—the two tracks (standard-gauge) upon which the wheels move being 56 feet center to center. The cantilever overhang, which may be also used as a jib for setting tall masts, is 94 feet long and when in a horizontal position forms, with the inshore portion, a continuous runway for the hoisting trolleys over 160 feet in length; and, therefore, owing to the open construction of the supporting frames, material may be taken from cars on a railroad inside of the crane-track and conveyed thence directly to the position for which it was designed on board the vessel building. The two trolleys have a combined maximum capacity of 168,000 pounds; and the smaller one traversing a track on the inside flanges of the plate girders is designed to lift and transport a load of 56,000 pounds, the speeds being respectively 22 and 150 feet per minute, while the other, with a capacity of just double this, raises its load 11 feet per minute and carries it horizontally at twice this speed. The two, being capable of working simultaneously in connection with the same piece of material to be handled, and being independently controlled, are most efficient adjuncts for setting into position the heaviest and most delicate parts of the ship's equipment. The 10-ton lifting tackle at the extreme outboard end serves for handling small loads and for the jib tackle when the cantilever is in an inclined position. This crane is self-propelling, is electrically driven throughout, and forms unquestionably the most elaborate machine of its class in the world. It is used in the shipyards of the Fore River Company.

Of the stationary dock cranes, including as they do the various kinds of shear legs, which are merely simple hinged or fixed struts for the support of the lifting tackle, there are very many, and for the most part wholly diverse examples to be found in nearly every shipyard. These are the oldest of modern ship cranes in point of development, for they form the next step after the abandonment of the crude jib; and, though their usefulness is materially impaired by the fact that all articles to be handled and every vessel to be dismantled or equipped must be brought within the radius of their action, they may, on account of this very feature, be designed for much heavier loads than either the movable dock or the floating cranes. Some of this kind are very intricate and elaborate, and particular reference is made to a noteworthy example (page 73) which is now in use in the yards of the Newport News Shipbuilding and Dry Dock Company. This has a capacity of 175 tons, which weight, together with that of the heavy superstructure, is supported upon a massive circular base, built of structural-steel shapes and plates. The jib is moved vertically by means of a most unusual belted mechanism, clearly shown in the accompanying illustration, and revolves horizontally upon a continuous line of wheels securely fastened each to each, the power being applied through a train of gears, the final one of which engages a rack located on the crane base proper. The remainder of the transportation equipment employed by this company merits especial attention, for it is all of this highest class, and has contributed in no small measure to the unusual success of this typical and thoroughly American concern.

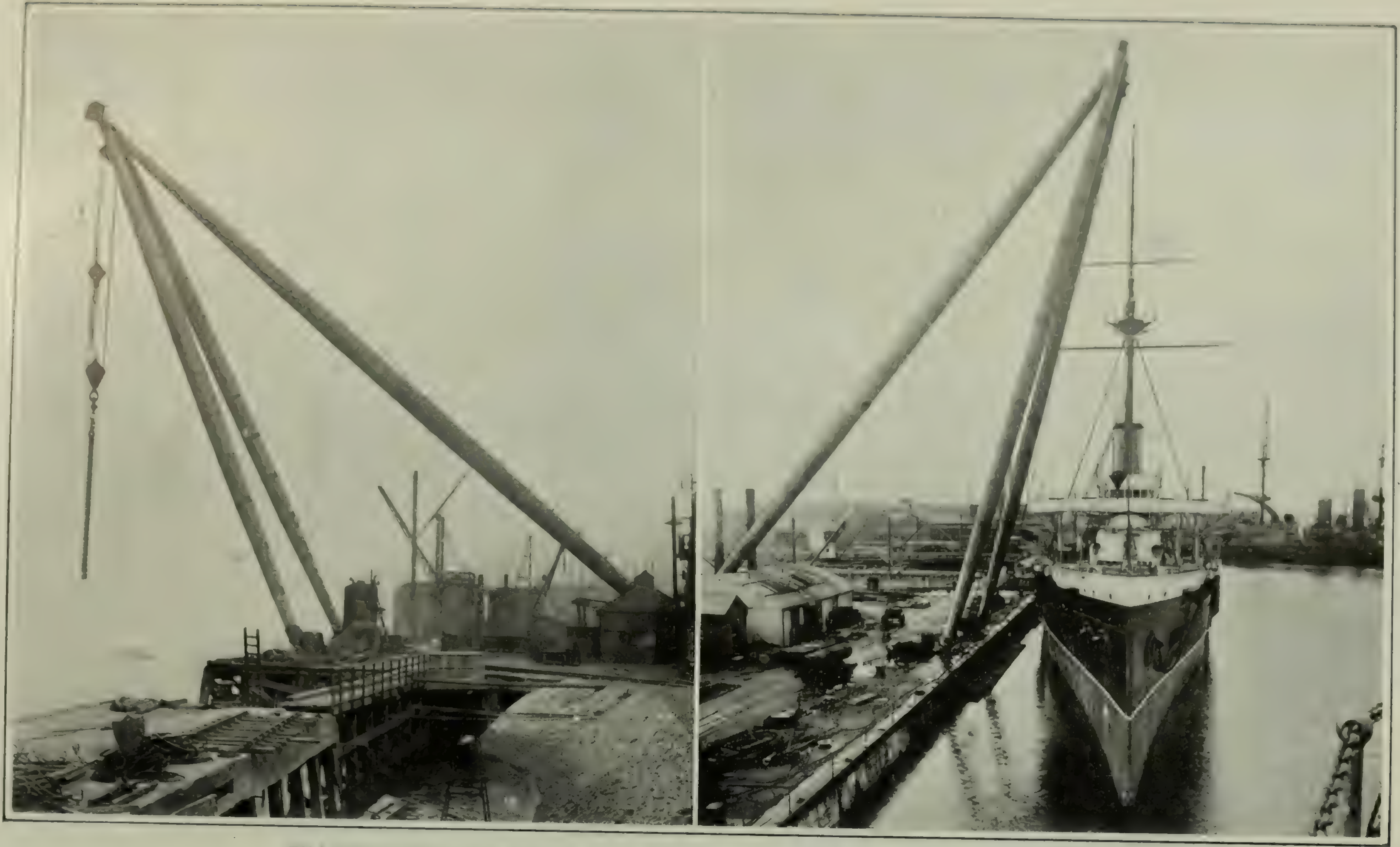


FIXED DOCK CRANE UNDER TEST, NEWPORT NEWS SHIPBUILDING CO.

The test load is of 300,500-lb. weight.

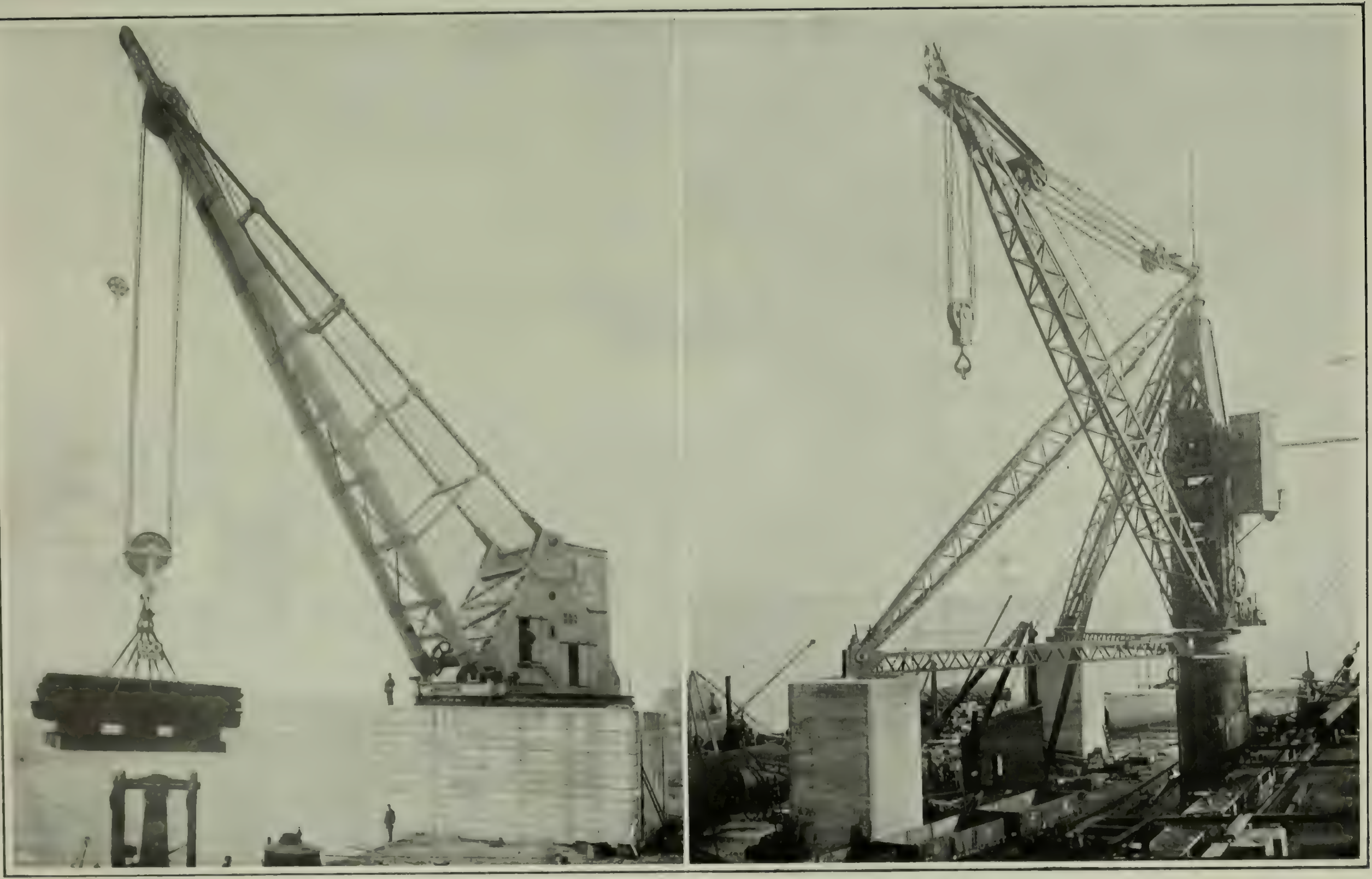
Floating cranes are perhaps the best examples of shipyard cranes proper, for they are the direct and ultimate result in the evolution of the simple jib attached to the mast of nearly every sailing vessel; but the modern structures of this kind are, too, the production of the manufacturer of the steel- and ore-handling appliances, and their development has been just as dependent upon these types as those others above described, ample proof of which is the fact that no improvements were made in them until this other transportation equipment had reached a very high state of perfection.

The most widely employed type of this class of machinery is that consisting of a heavy, rigid, vertical A-frame, from the top of which is led a tension member (usually capable of being shortened) supporting at its outer end the strong, swinging jib, securely fastened at the lower extremity to the pontoon between the legs of the A-frame. The hoisting mechanism is rigged to the end of this jib, and the



EXAMPLES OF LARGE SHEAR LEGS ERECTED IN BRITISH SHIPBUILDING YARDS.

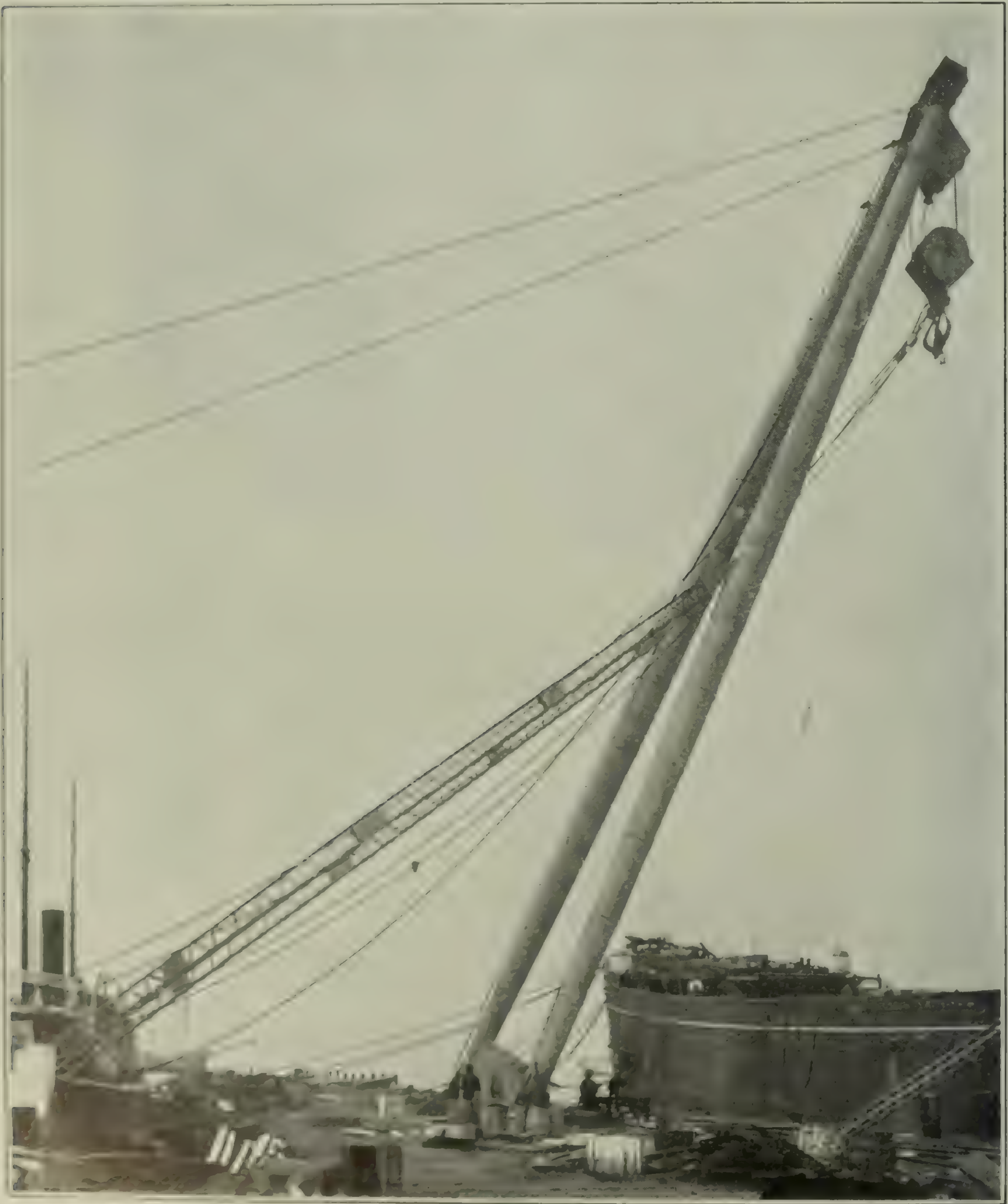
Those on the left, built by Hanna, Donald & Co. in 1902 in the yards of Palmer's Shipbuilding & Iron Co., Jarrow-on-Tyne, are of 120 tons working load; front legs 135 ft. long, 4 ft. 8 in. diam. at middle; back legs 185 ft. by 5 ft. diam. at middle; outboard reach 60 ft.; two 15 by 15 engines for hoisting and two 18 by 16 engines for traversing. The legs on the right are also of 150-tons capacity, erected at one of the Royal Dockyards by Cowans, Sheldon & Co. All motions are controlled by one man.



HIGH POWER STEAM AND ELECTRIC WHARF AND SHIPYARD CRANES.

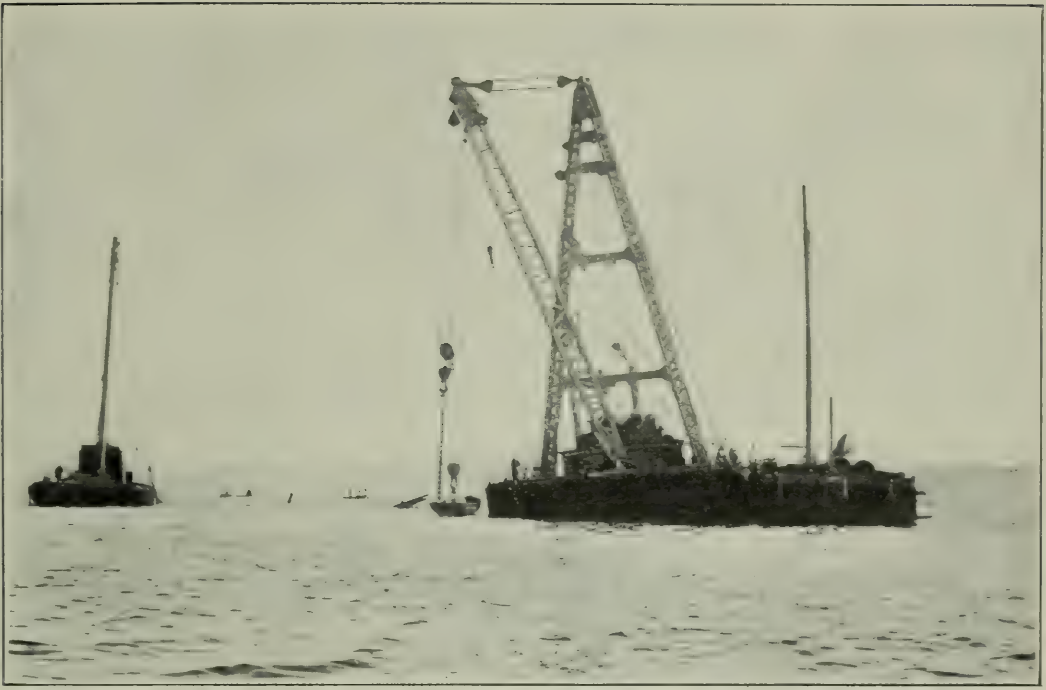
The one on the left is a 150-ton steam wharf crane, built by Cowans, Sheldon & Co., for the Trustees of the Clyde Navigation; radius 65 ft., weight 370 tons. The one on the right is a 125-ton electric derrick crane lately built for Scott's Shipbuilding & Engineering Co., Ltd., Greenock, by George Russell & Co., Motherwell. Lifts 120 tons at radius of 70 ft. and with light-purchase gear handles 10 tons at 98 ft.; minimum radius 25 ft.; hoisting speed 5 ft. per minute with 120 tons and 40 ft. per minute with 10 tons. 50-h.p. motor for main hoist and derricking motions, 35-h.p. for light hoist and slewing. All enclosed tramway type. All motions controlled by one man.

lightness and the compactness attainable (though the radius of action is of necessity restricted) for even the largest capacities make this crane very useful for wrecking and general shipyard work. The most notable of these cranes is the Monarch, owned by the Merritt Wrecking Company; and, with a capacity of 275 gross tons, it is unique in size among floating craft of this character.



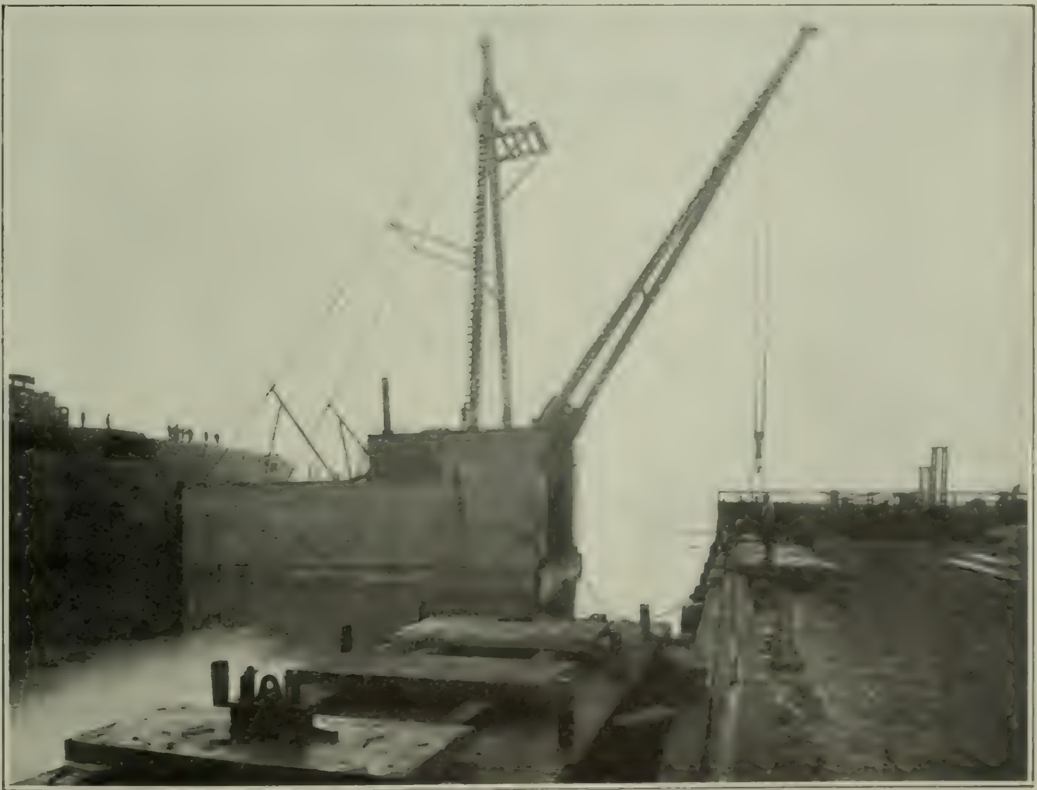
SHEAR LEGS, NEWPORT NEWS DRYDOCK & SHIPBUILDING CO., NEWPORT NEWS, VA.

Citations could be multiplied of floating cranes with distinctive features, for nearly all have some modifications introduced by the designer or to meet some special requirement; but reference to the accompanying photographs will show how widely these machines



WRECKING CRANE "MONARCH," 275-TONS CAPACITY, AT WORK RAISING THE "GEN. SLOCUM."

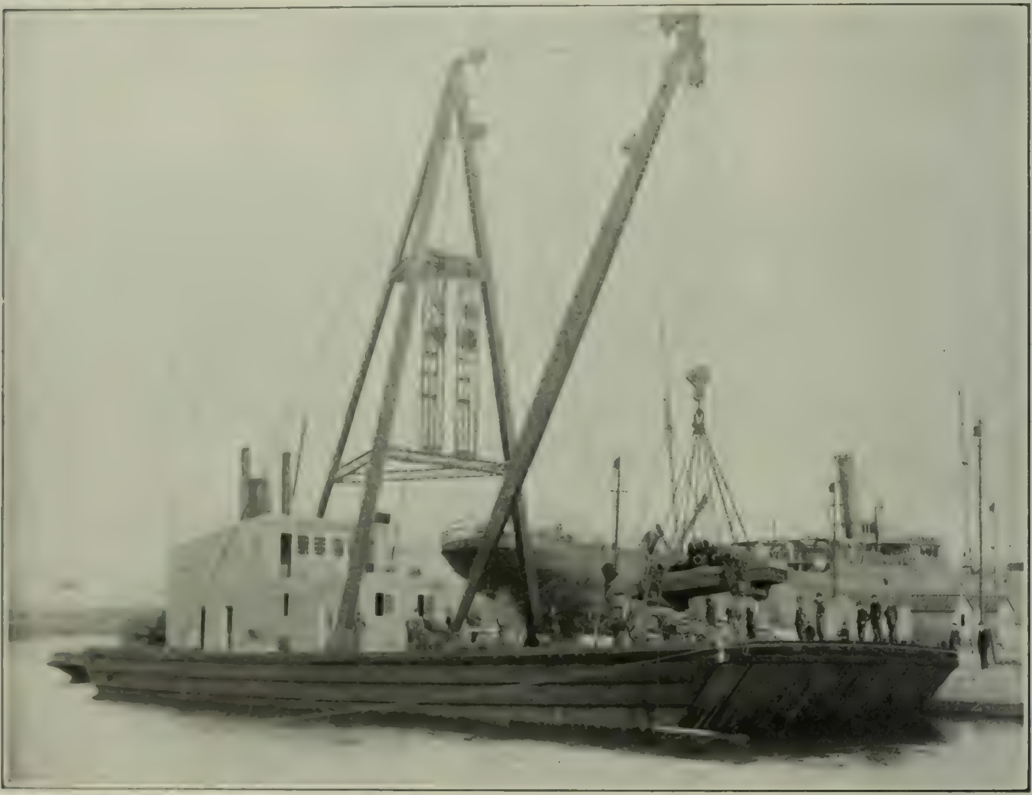
Merritt-Chapman Wrecking Co.



SEVENTY-FIVE-TON WOODEN FLOATING CRANE AND FLOATING DRYDOCK, COMBINED.

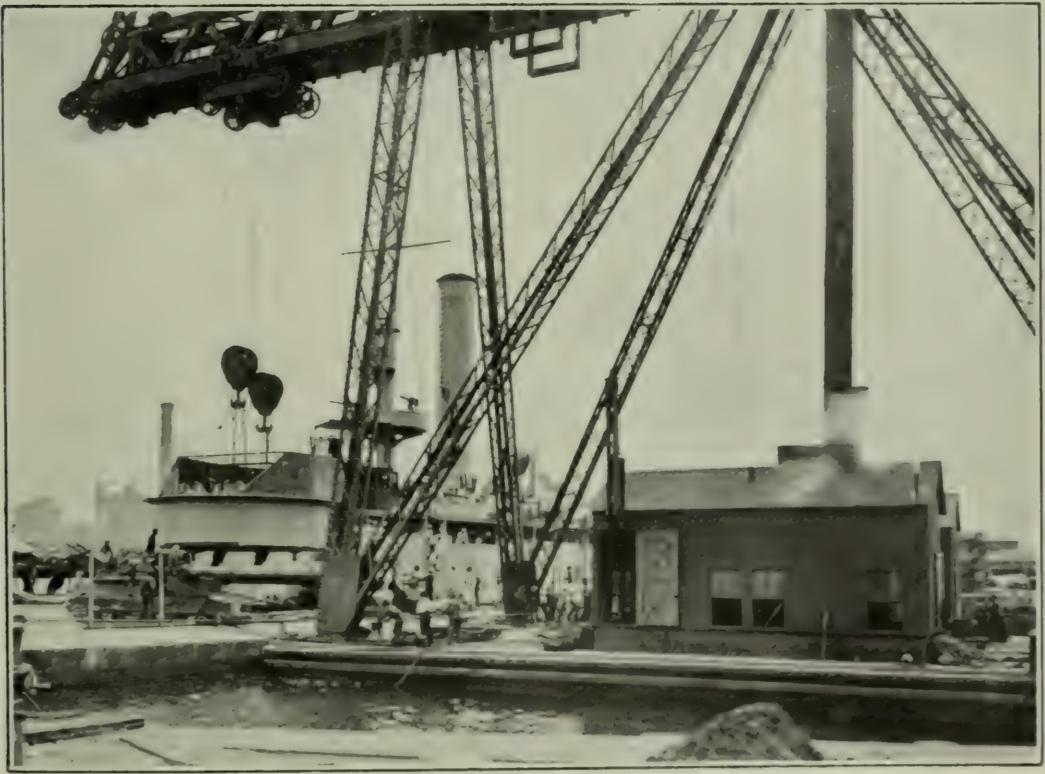
Built by Moran Shipbuilding Co., Seattle, Wash., and used in their yards.

differ when a comparison is made between the 40-ton structure composed of a horizontal beam supported upon an elaborate revolving base, and the 75-ton wooden jib crane used by the Moran Shipbuilding Company, not only as a crane proper, but as a floating drydock as well as for small craft. They are shown together on the preceding page.



ONE-HUNDRED-TON SWINGING-JIB FLOATING CRANE, U. S. NAVY YARD, NORFOLK, VA.
Built by Snare & Triest.

There is one construction, however, in this class which calls for a particular description for, to my mind, it marks at once the culmination in crane-building practice and forms the most unique example of the general usefulness to which such a machine, properly designed, can be placed. This is the 100-ton steel floating crane employed in the building and the overhauling of naval vessels at the United States Navy Yard at New York. The simplicity in its design is a most striking feature, for it is made up of a horizontal truss, 210 feet 6 inches in over-all length, supported by eight inclined struts, of a light appearance but of unusual strength and stiffness, which are fastened through massive connections to the four corners of the steel pontoon. This is 60 feet wide, 100 feet long, and 11 feet 3 inches deep. The trolley runway has a total length of 190 feet, and the single compact trolley supports the two ponderous blocks, each controlled independently, which are capable of separately lifting and handling a nominal weight of 50 gross tons, but which can in cases of emergency transport with absolute safety a load of 134,400 pounds. The engines and boilers are installed in the port and starboard sides respectively, and the middle portion, carefully separated from the remainder of the pontoon by watertight bulkheads, is reserved for the massive counterweight device, which balances (by means of an automatically operated throttling engine) the load on the blocks, in every position, and with such precision that the deviation of the plane of the deck from that of the horizontal never exceeds 1 degree and 30 minutes. In the extreme position the center of the blocks is 45 feet from the edge of the end of the pontoon, and they are capable of being lowered from their highest position, which is 64 feet above the deck, to a point 22 feet below it. For supporting and conveying the loads for which this structure was designed there is installed 5,565 feet of plough-share steel rope 1⅛ inches in diameter; and 48 steel sheaves, exclusive of the 4 in each block, each 4 feet in diameter, serve as guides for this enormous length of cable.



ONE-HUNDRED-TON PONTOON CRANE WITH 120-TON TURRET ON THE BLOCKS, N. Y. NAVY YARD.

Built by Brown Hoisting Machinery Co.

The uses to which this craft has been put since its acceptance on July 30, 1903, have been more numerous and more diverse than those of probably any other crane in the world. It has placed in position armor plate for the U. S. S. Connecticut; it has removed and replaced, without a single mishap, the 13-inch guns, the 100-ton turrets, and other heavy ships' equipment of over a dozen war vessels; it has set the granite facing, and provided the power for dressing it, on a pier 65 feet wide and 500 feet long; it has removed the piling from an old quay wall obstructing the ways from which the Connecticut was launched; and in a score of other instances proved an invaluable adjunct in the operation of this most important naval plant. That it is economical in working is shown by the fact that there was actually expended $200 for taking off a defective 13-inch gun from the U. S. S. Kentucky, conveying it on the deck (which is capable of sustaining a load of 300 gross tons with a 2-foot freeboard coincident with a full load on the blocks) to Jersey City, there unloading it and bringing back a new one and replacing it in its proper position. The saving thereby resulting is rather remarkable, for the lowest bid from a private concern was $4,000 for the job. That its importance is universally recognized is amply verified by an offer of $250,000—or two and one-half times its cost to the Government—made by a European state when, early in 1903, darkening war clouds began to threaten the peace of the world.

Such is the machinery equipment for one department at the disposal of American shipbuilding concerns, and that for the others is in no whit inferior. Why then need pessimists decry American maritime-construction work? Undoubtedly as soon as capitalists deem all conditions opportune (and I am firmly of the mind that they have already so decided) for active participation in the building of vessels for the ocean and coastwise carrying trade, there will be no difficulty experienced in producing finished craft at prices which will guarantee a paying profit, and at the same time be no more expensive than foreign constructions to the shipowners.

THE SUPERHEATING OF STEAM, AND ITS INFLUENCE ON ENGINE ECONOMY.

By R. M. Neilson.

In a preceding paper, Mr. Neilson reviewed the leading types of apparatus and modes of superheating. He now discusses the results secured by their use.—THE EDITORS.

II. THE INCREASE OF EFFICIENCY BY THE USE OF SUPERHEAT.

IT is generally acknowledged that the use of superheated steam raises the efficiency of a steam engine, be it reciprocating or turbine. Why it raises the efficiency is a question which is being continually asked but which has not yet received an answer of general acceptance. One reason often urged to explain the increase of efficiency with reciprocating engines is that an important cause of loss with such engines—especially with certain types—is leakage past the valve or valves, and that the escape of wet steam through very narrow passages is greater than that of dry steam, thus giving an advantage to superheated steam, which will always be dry—at least, till it gets into the cylinder. Certain experiments that have been made seem to bear out this view; but hardly enough is known on the subject to enable us to say more than that this is a possible cause.

Another reason which seems to be well established for the increase of efficiency with reciprocating engines is that, when saturated steam is used, a great quantity is wasted by condensing on entering the cylinder and remaining condensed till exhaust takes place. The reason for the condensation is that the metal surfaces with which the live steam comes into contact have just previously been in contact with the exhaust steam. When superheated steam is employed in place of saturated steam, it is of course cooled by contact with the cold metal surfaces, but it loses less heat than does the saturated steam, in spite of the fact that with the superheated steam there is a greater difference of temperature between the steam and the cold surfaces than with the saturated steam.

This greater loss of heat by the saturated steam is due to the fact that with the saturated steam there is always a film of moisture (sometimes more than a film) covering the surfaces with which the entering steam comes into contact. Even if the saturated steam arrives at the engine dry, it has no heat to give up to dry the surfaces wetted by the previous exhaust, except by condensing. Now this film of water serves as a ready means of transferring heat from the steam to the metal. The steam is therefore robbed of much more heat than it would lose if the surfaces were dry. When superheated steam is used, the surfaces are at once dried by the steam which without condensing can spare heat which can be used in evaporating the moisture on the metal surfaces. Thereafter, with the surfaces dry, the steam gives up to them comparatively little heat.

With turbines the gain of efficiency with superheated steam cannot be due to this cause (prevention of initial condensation), for in a turbine, getting a uniform supply of steam, each part of the turbine comes in contact with steam of only one temperature. It is true that if the supply of steam is not uniform, but arrives in puffs, or if the initial steam pressure is constantly being changed to suit the load, or if the amount of superheat in the steam varies—then each part of the turbine will not come into contact always with steam at the same temperature; but the conditions conducive to initial condensation existing in a reciprocating engine are not approached. In a turbine of the Parsons type there is no doubt that the prevention of the deposit of water on the inside of the turbine casing during the early stages of expansion, by the use of superheated steam, will reduce the transfer of heat to the casing, and so diminish the radiation losses; but not more than a small part of the increase of efficiency due to superheating can be attributed to this cause. The chief cause of the increase of efficiency in turbines due to superheating is probably the diminution of fluid friction within the turbine.

This fluid friction in steam turbines is a very important item, and it is found that dry steam causes much less friction than wet steam at the same pressure. The superheat given to the steam is usually not sufficient to keep it dry till it leaves the turbine. In fact, with de Laval turbines using superheated steam, the superheat is usually all gone and the steam wet before the fluid reaches the turbine wheel. Nevertheless, the fact that the steam is dry during part of its expansion and less wet than it would otherwise be during the remainder of its expansion, may cause a very considerable diminution of friction. Of course, the work expended in friction in a steam turbine is not altogether lost; but it would be going beyond the scope of this article to discuss the utilisation of friction-produced heat.*

It is sometimes asserted that the reduction in steam consumption brought about by superheating the steam to a moderate extent, say by about 150 degrees F., is largely due to the increased volume given to the steam when being superheated. It is true that a small percentage additional heat given to steam in superheating it produces a large increase in its volume; but it must be remembered that superheated steam expands in a different way from saturated steam, and it must not be assumed that the amounts of work to be got from saturated steam and from superheated steam respectively during expansion are proportional to the respective volumes before expansion. As a matter of fact, the adiabatic expansion line for superheated steam falls much more rapidly than the adiabatic expansion line for saturated steam. The additional volume obtained by superheating is cheaply bought for heat and is cheaply sold for mechanical work. There is a thermodynamic gain, but it is very slight and does not account for more than a small part of the reduction in steam consumption.

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* Those interested in this question are referred to *The Engineer*, London, Sept. 4, 1903, page 245.

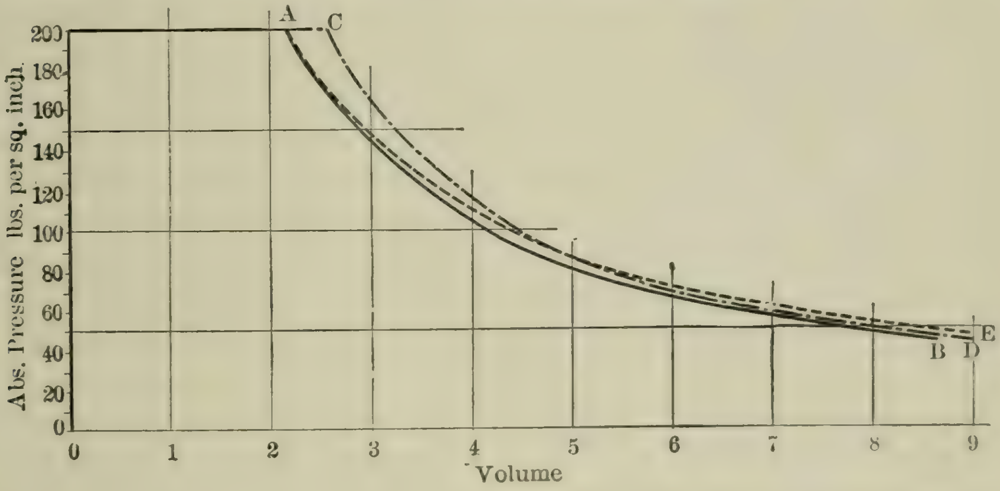


FIG. I. EXPANSION OF SATURATED AND SUPERHEATED STEAM COMPARATIVELY SHOWN.

Adiabatic expansion curves for saturated and for superheated steam are given in Figure 1, where they can be compared. The full line A B represents the adiabatic expansion line of saturated steam starting at 200 pounds per square inch absolute. The chain line C D represents the adiabatic expansion of the same weight of steam which is superheated at 200-pounds pressure absolute from the boiling point 382 degrees F. to 510 degrees F. and before it is allowed to expand adiabatically.

When saturated steam expands adiabatically some of it condenses and the volume is reduced in consequence. If, in the case in question, sufficient heat had been supplied to the saturated steam during expansion to prevent condensation but not to superheat the steam, the expansion curve would have been as shown by the dotted curve

AE. Now the superheated steam in question will not remain superheated throughout the expansion: this is well known. As a matter of fact, the superheat will be gone by the time it has expanded to a pressure of about 70 to 100 pounds absolute (the precise pressure depends on the laws of expansion of superheated steam which we do not know with exactness). The line of expansion of the superheated steam therefore cuts the dotted line AE at this pressure as shown in the figure; and from this point the steam originally superheated expands as saturated steam and keeps below the dotted curve A E, getting continually wetter and wetter as it expands.

If the weight of steam dealt with is one pound, the figures in the diagram indicating volume will represent cubic feet. The curves will however represent the expansion of any weight of steam whatever, the horizontal row of figures representing relative volumes. The expansion curves have been stopped at about 40 pounds absolute in order to keep the diagram within reasonable dimensions. If however the diagram had been continued to a very low pressure, the curves AB and CD would have been found to keep close together for the remainder of their lengths.

It will be seen that, although the superheated steam has at the start a volume considerably greater than the saturated steam, the ratio of the volumes rapidly diminishes. The work got out of the superheated and saturated steam respectively when expanded to any pressure and discharged at that pressure can be obtained by drawing a horizontal line at that pressure to meet the expansion curve. The area of the figure enclosed by the expansion curve, this horizontal line, the horizontal line at 200-pounds pressure, and the line of zero volume, will then represent the work got out of the superheated or saturated steam as the case may be.

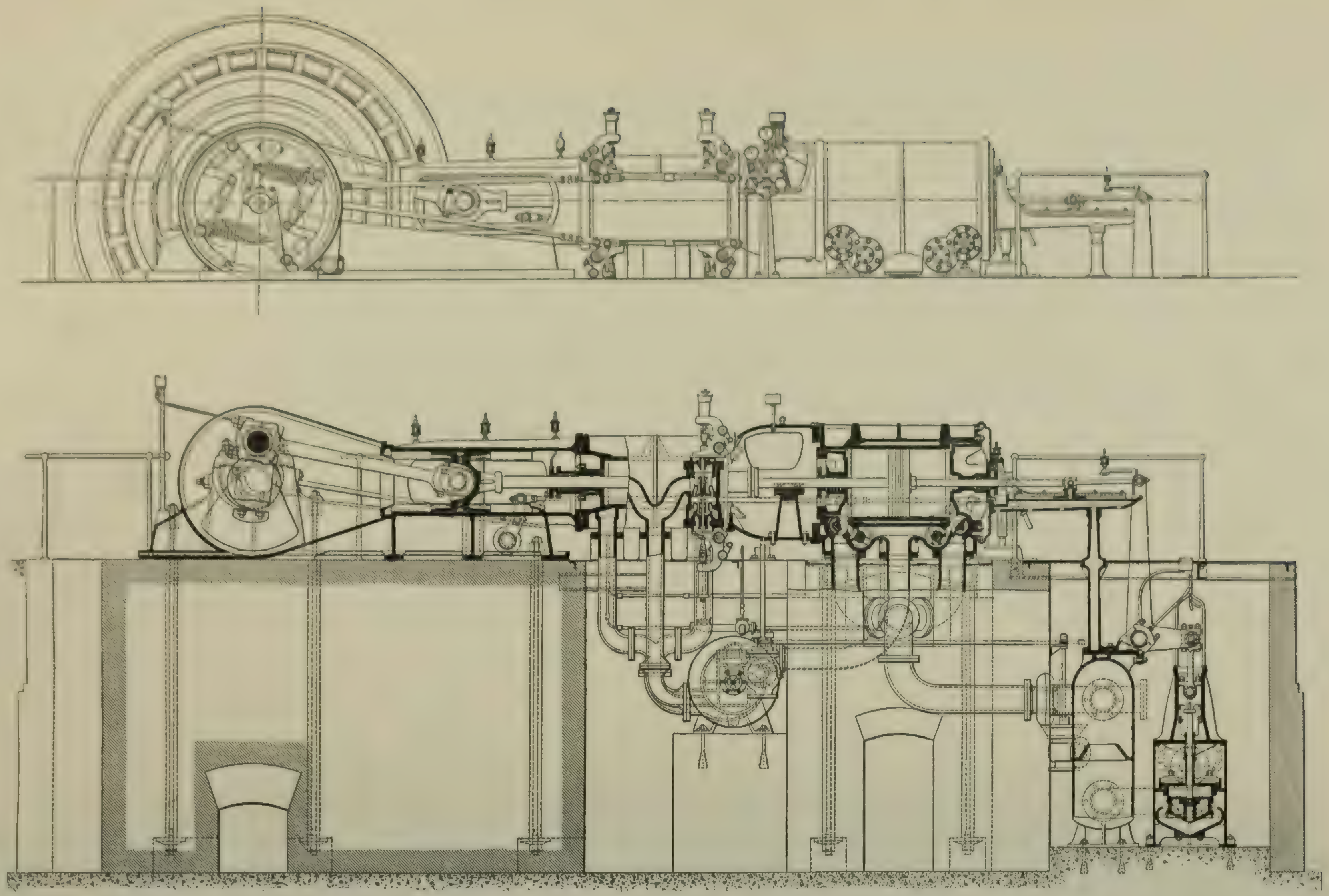
If the lower pressure be taken at 0.6 pounds absolute, which means an exceedingly good vacuum for a steam engine, the work done by the superheated steam will be found to be only about 6 or 7 per cent. greater than the work done by the saturated steam. As about 5 per cent. additional heat has to be supplied to superheat the steam, it will be seen that the thermodynamic gain is very slight. The thermodynamic gain is better seen on an entropy temperature diagram; but a pressure-volume diagram has been selected in this case in order to show the relative volumes.

In my opinion the gain obtained by moderate superheating cannot be attributed, except to a small extent, to increase of volume, and is really due in the case of turbines to the reduction of friction and in the case of reciprocating engines largely at least to reduction of initial condensation. As a good vacuum with reciprocating engines is conducive to great initial condensation, it would seem that superheating should be more beneficial to reciprocating engines when a good vacuum is used than when a poor vacuum is used.

The greater part of the economy to be derived from the use of superheated steam can be obtained without exposing the engine to high temperatures, by compounding and employing a reheater to superheat the steam passing from the high-pressure to the low-pressure cylinder. The cut-off in a single-expansion engine is of course much earlier than in the high-pressure cylinder of a compound engine having the same total range of expansion. For this reason it requires very much less initial superheat to keep the steam dry to exhaust in the high-pressure cylinder of the compound engine than in the single-expansion engine. Moreover, the steam will suffer less loss of heat in entering the high-pressure cylinder of the compound engine than in entering the cylinder of the single-expansion engine, because the former cylinder is at higher temperature than the latter and this will still further reduce the amount of initial superheat required by the compound engine compared with the single-expansion engine. If the steam exhausting from the high-pressure cylinder of the compound engine is superheated before entering the low-pressure cylinder, so as to carry it through that cylinder dry, the compound engine will receive the same benefit by superheating as the single-expansion engine so far as regards dryness of the cylinder walls, etc.

If the steam is not superheated sufficiently to carry it dry right up to the point of exhaust, the comparison made above still holds good. That is to say, if the initial superheat in the case of the single-expansion engine is sufficient to keep the steam dry to a certain point in the stroke, then in the case of the compound engine a much less initial superheat, together with a drying and superheating of the steam in the reheater, will give equivalent advantages as regards dryness. The amount of superheat which would need to be given initially to the steam in a single-expansion engine to carry it through dry to the exhaust would, of course, be very great with a high steam pressure, especially for a condensing engine. There is, however, a thermodynamic advantage in superheating the steam all at once instead of at two stages.

This is due to the heat for superheating being absorbed by the steam at a higher average temperature. Whether this advantage is sufficient to counterbalance the disadvantage of the higher initial temperature is an open question. In many cases, however, an existing compound engine has to be used which certainly cannot stand



FIGS. 2 AND 3. HORIZONTAL TANDEM-COMPOUND ENGINE, WORKING WITH SUPERHEATED STEAM ON THE SCHMIDT SYSTEM.

Cylinder 15 and 24 by 28 in.; 140 revolutions; 140-lb. pressure, temperature at engine 750° F. Built by Easton & Co., Ltd., London and Erith, for Brantham Works of the British Xylonite Co., Ltd. By Courtesy of *The Engineer*, London.

very highly superheated steam, and this stage superheating is in such a case the best means of obtaining the maximum economy.

With single-expansion engines using superheater steam the cylinder may be jacketed with the superheated steam. This jacket will then act somewhat like the reheater of the compound engine and allow a lower initial superheat temperature to be employed without loss of economy. With compound engines using superheated steam, the high-pressure cylinder is sometimes jacketed with the superheated steam and a reheater employed in addition to this. A jacket should, however, be employed only when sufficient initial superheat cannot be given to keep the steam dry till it leaves the cylinder. Even when this condition is barely fulfilled, the jacket may cause more loss than gain. There is no excuse for a jacket on the low-pressure cylinder of a compound engine using superheated steam.

With a triple- or quadruple-expansion engine, the steam can be superheated before use in each of the three or four cylinders (or sets of cylinders). It will be advisable, however, whenever possible, to omit the last stage reheater in the case of the triple-expansion engine, and the last two reheaters in the case of the quadruple-expansion engine, and in place of these to give the steam additional superheat at the first reheater. It is not likely that quadruple-expansion reciprocating engines will ever be built for use with superheated steam; but existing engines may have to be adapted to use it.

It is usually not convenient to superheat the steam in a reheater by a fire or by products of combustion from a fire. It is therefore common practice to employ as a heating agent some of the steam which comes from the primary superheater. The reheater may be a box in which are placed coils of tube through which passes the high-temperature steam. The steam to be reheated passes through the box and outside the coils of tube. The high-temperature steam transfers to the low-temperature steam some of the heat it has acquired, without any serious waste.

A good example of a compound engine using superheated steam with a reheater between the cylinders is shown in Figures 2, 3, and 4.

The details of the receiver in which the steam is heated between the high- and low-pressure cylinders are shown in Figures 2, 3 and 4. This engine was one of two constructed by Messrs. Easton & Co. (now Easton & Anderson) of Erith and London, for the British Xylonite Co., Ltd. The cylinders are 15 and 24 by 28 inches and the revolutions per minute 140. The high-temperature steam from the superheater is passed through the tubes in the receiver as shown in Figures 3 and 4. There are 55 tubes, 20 millimeters internal diame-

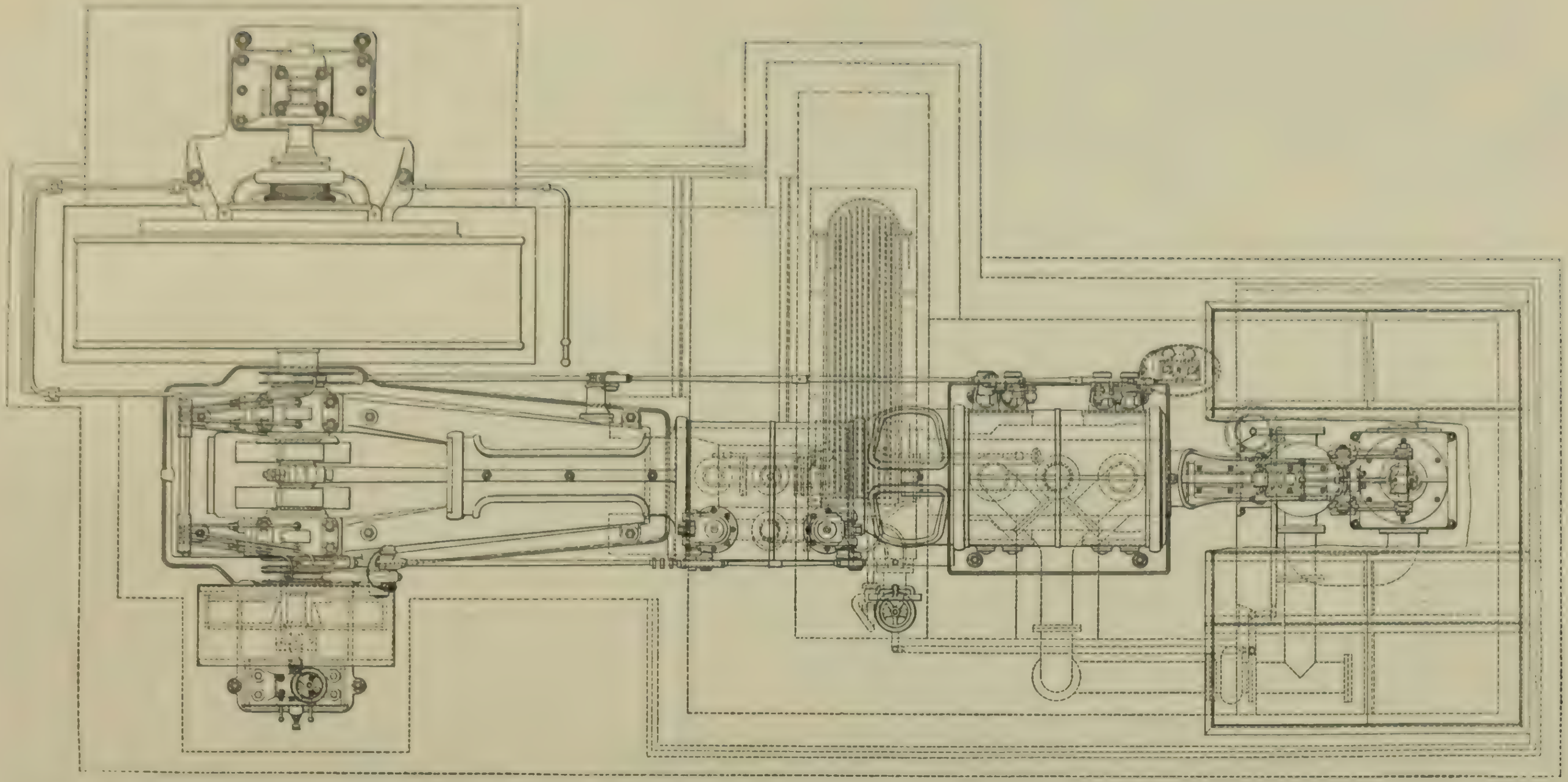


FIG. 4. HORIZONTAL TANDEM-COMPOUND ENGINE WORKING WITH SUPERHEATED STEAM ON THE SCHMIDT SYSTEM. PLAN.
By Courtesy of *The Engineer*, London.

ter and 28 millimeters external diameter. The tubes are of course of unequal length, as can be seen from Figure 4. The average length is about 7 feet bent or 14½ feet unbent. The total length of the receiver, including the valve chamber at the end, is 9 feet 1 inch and the diameter is 2 feet 7 inches. The steam after passing through the tubes, which are all in parallel, and after having its temperature thus considerably reduced, proceeds to the high-pressure cylinder. The exhaust from the high-pressure cylinder is taken to the receiver and makes contact with the outside of the tubes within the receiver. A plate is arranged centrally within the receiver from the tube plate to near the curved ends of the tubes. This causes the steam which has to be reheated to pass twice along the length of the receiver box. Figures obtained during a test of this engine by Prof. Ewing are given in Tables VI and VII.

Figures will now be given to show the reduction in steam consumption to be brought about by superheating. Tables I, II and III refer to turbines and IV, V, VII and VIII to reciprocating engines.

TABLE I.*—TEST OF 500-KILOWATT TURBO-ALTERNATOR CONSTRUCTED BY MESSRS. C. A. PARSONS & CO. FOR THE CORPORATION OF BLACKPOOL.

Pressure of steam above atmosphere at stop valve in lbs. per sq. in.	Superheat at stop valve in degrees F.	Vacuum in turbine cylinder in ins. of mercury Bar.=30"	Revs. Per min.	Load in Kilowatts.	Steam used.	
					lbs. per hr.	lbs. per K.W. hr.
146	70	27.1	2.500	515	11,000	21.35
150	0	27.0	2,500	502	11,600	23.1
135	0	27.3	2,500	497	11,953	24.0
133	66	27.3	2.500	507	10,693	21.1

TABLE II.*—SUMMARY OF TESTS OF A 300 B. H. P. DE LAVAL STEAM TURBINE AT TRENTON, N. J., U. S. A.

Duration of test in hours.	Average steam pressure before governor valve in lbs. per sq. in.	Average steam pressure after governor valve in lbs. per sq. in.	Average vacuum in inches of mercury.	Barometer in inches of mercury.	Average temperature of room in degrees Fahr.	Average superheat before governor valve in degrees Fahrenheit.	No. nozzles open.	Revolutions per minute of generators.	Average brake horse power.	Lbs. of steam per hour.	Lbs. of steam per B.H.P. hour.
6	207.0	198.5	27.2	30.18	83	84	8	750	352	4906	13.94
2	207.4	197.0	27.4	30.07	90	64	7	756	298.4	4282	14.35
6	201.5	197.2	27.4	29.79	89	13	5	745	196.2	3047	15.53
4	206.4	196.9	26.6	29.92	90	0	8	747	333.0	5052	15.17
2	207.3	196.5	26.8	29.90	97	0	7	746	284.8	4430	15.56
2	207.6	195.8	27.3	29.83	97	0	5	751	195.2	3229	16.54
3	201.5	197.9	28.1	29.81	80	0	3	751	118.9	1950	16.40

Figures showing the percentage reductions in steam consumption due to superheating have been calculated or collected by the author from a number of tests made in Great Britain, the Continent of Europe, and America, and are tabulated in Tables III and VIII.

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* The Steam Turbine, by R. M. Neilson. Longmans & Co.

Table III.—Reduction in Steam Consumption in Steam Turbines, Due to Superheating. Statistics Obtained from a Number of Tests.

Degrees Fahrenheit of superheat.	Percentage reduction of steam consumption.	Percentage reduction per degree Fahrenheit.
13	6.1	0.47
50	8.0	0.16
60	5.4	0.09
66	12.1	0.18
70	7.5	0.11
84	7.7	0.09
100	14.0	0.14
140	12.6	0.09
150	19.0	0.13
200	23.0	0.115
260	24.5	0.09

Table IV.—Reduction in Steam Consumption in Reciprocating Steam Engines Due to Superheating. Statistics Obtained from a Number of Tests.

Degrees Fahrenheit of superheat.	Percentage reduction of steam consumption.	Percentage reduction per degree Fahrenheit.
31	7.86	0.25
40	8.65	0.22
50	12.00	0.24
100	20.55	0.20
150	13.00	0.09
216	36.4	0.17
225	33.7	0.15
225	33.1	0.15
440	30.9	0.07

The figures in Table VI are obtained from Prof. Ewing's report as are also the figures in Table VII, which belong to the same test. The boiler was of the Lancashire type and the superheater of the Schmidt independently fired type. The steam was reheated between the high- and low-pressure cylinders, the heat being obtained from the superheated steam on its way from the superheater to the high-pressure cylinder. The engine is illustrated in Figs. 2, 3, and 4. The curve of total steam consumption of the engine is given in Figure 5, the position at which actual measurements were taken being indicated.

The reduction in steam consumption does not of course necessarily represent the reduction in coal consumption. Heat must be given to the steam to superheat it. If this heat is supplied by the waste gases leaving the boiler, which would otherwise pass away unused, then the superheat is obtained for nothing and the table represents the saving in coal as well as in steam. It is obvious, however, that we are not in this case making a fair comparison of the merits of superheated and of saturated steam, as when we use the latter we are sending away our waste gases at a higher temperature than with the former while there is no good reason why we should do this.

One means for getting at the reduction of coal consumption which

TABLE V.*—TESTS BY PROF. SCHRÖTER OF HORIZONTAL COMPOUND TANDEM RECIPROCATING STEAM ENGINE AT GHENT.

	Indicated load in horse power.	Length of trial in minutes.	Consumption of steam per hour in kilograms.	Consumption of steam per hour per I.H.P. in kilograms.	Temperature of steam at introduction in degrees Centigrade.	Equivalent consumption of saturated steam per I.H.P. hour in kilograms.	Percentage of economy by superheating on the consumption of saturated steam.	Consumption of heat per I.H.P. per hour in calories.
Saturated Steam Varying Power	312.17	60.16	1902	6.09	180.7	. . .	. . .	4029
	273.02	61.04	1560.8	5.72	180.1	. . .	. . .	3783
	219.03	57.54	1197.7	5.47	180.3	. . .	. . .	3618
	167.65	54.96	885.5	5.28	178.7	. . .	. . .	3490
	166.77	50.34	526.6	5.37	178.9	. . .	. . .	3550
	21.50	53.23	131.9	6.13	. . . .	. . .	. . .	4054
Superheated Steam Varying Power	314.22	48.15	1527.3	4.86	299.6	5.28	13.3	3493
	268.84	59.69	1249.3	4.65	305.8	5.07	12.1	3355
	220.24	50.82	12	4.46	306.4	4.87	11	3220
	167.65	64.66	728.2	4.34	304.3	4.73	10.4	3130
	119.36	54.96	515	4.31	304.6	4.70	12.5	3108
	222.87	73.70	1170.5	5.25	204.3	5.34	2.4	3534
Constant Power Varying Superheat	223.90	58.05	1116.2	4.99	233.6	5.19	5.1	3430
	220.29	47.61	1065.6	4.84	263.4	5.14	6	3397
	219.75	337.54	977.6	4.45	303.1	4.85	11.3	3206
	215.19	57.18	864.9	4.02	352.8	4.52	17.3	2992

TABLE VI.—TESTS BY PROF. EWING OF A HORIZONTAL TANDEM TWO-CYLINDER COMPOUND ENGINE OF 300 H. P. BUILT BY MESSRS. EASTON & COMPANY, LTD., AT THE BRANTHAM WORKS OF THE BRITISH XYLONITE COMPANY, NEAR MANNINGTREE.

					Pounds of steam		
Trial No.	Date of trial.	Indicated horse-power.	Electrical horse-power.	Ratio of electrical horse-power to indicated horse-power.	Total per hour.	Per indicated horse-power hour.	Per kilowatt hour.
I	Dec. 16, 1902	312	255	.82	2,925	9.4	15.4
III	Dec. 17, 1902	239	192	.80	2,150	9.0	15.0
II	Dec. 16, 1902	175	130	.74	1,670	9.5	17.2
IV	Dec. 17, 1902	47	4.8	. .	975	. .	. . .

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* *Power*, June, 1903, pp. 288-293.

TABLE VII.—FURTHER PARTICULARS OF THE SAME TEST.

	Test No. I	Test No. III	Test No. II	Test No. IV
Boiler pressure, lbs. per sq in.	141	141	142	140
Corresponding saturation temperature	361° F	361° F	361½° F	360° F
Temperature at superheater	800° F	790° F	810° F	790° F
Pressure at engine, lbs. per sq. in.	134	135	139	138
Temperature of engine, before passing re-heater	737° F	734° F	761° F	...
Temperature at engine, after passing re-heater	554° F	590° F	603° F	...
Vacuum, inches of mercury[*]	27¼	28	28	29
Revolutions per minute of engine	140	140	140½	140

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[*] The height of the barometer was not stated.

TABLE VIII.[*]—TESTS BY PROF. D. S. JACOBUS OF RICE & SARGENT HORIZONTAL CROSS-COMPOUND RECIPROCATING STEAM ENGINE.

Date of test, 1903	May 27.	June 19.	July 17.	July 24.
Condition of steam. Superheated or saturated	Sup.	Sup.	Sup.	Sat.
Length of test in hours and decimals of an hour	5.15	6.033	6.00	6.50
Water feed to boiler in pounds per hour, corrected for leakage	4633	4018	2684	5630
Pressure of steam near throttle in pounds per square inch	141.2	142.4	145.6	145.1
Vacuum at condenser in inches of mercury	25.80	26.79	26.81	25.24
Barometric pressure in inches of mercury	30.16	29.80	30.01	30.00
Temperature of steam at the engine throttle in degrees F.	713.7	736.3	756.8	....
Amount steam was superheated at the engine throttle in degrees F.	352.5	374.5	393.3	....
I.H.P. developed by engine	474.5	420.4	276.8	406.7
Water consumption in lb. per hour per I.H.P.	9.76	9.56	9.70	13.84
Heat consumption in B.T.U. per min. corresponding to the heat in steam at the throttle valve, and the max. temp. of feed water—standard of Inst. of Civil Engineers (Great Britain)	205.0	203.7	208.8	248.2
Coal per hour per horse-power on basis of the heat consumption recommended as a standard by Inst. of Civil Engineers (Great Britain.) In this the loss due to radiation of the steam pipe from the boiler to the engine is not charged against the engine, and it is credited with the maximum temperature at which it can return the feed water to the boiler	1.265	1.257	1.288	1.497
Actual water evaporated and superheated per pound of dry coal in test made June 19		7.09		
Actual coal burned per hour per I.H.P.		1.348		

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[*] Paper read by Prof. Jacobus before the American Society of Mechanical Engineers, 1903. *Power*, Jan., 1904, pp. 39-42.

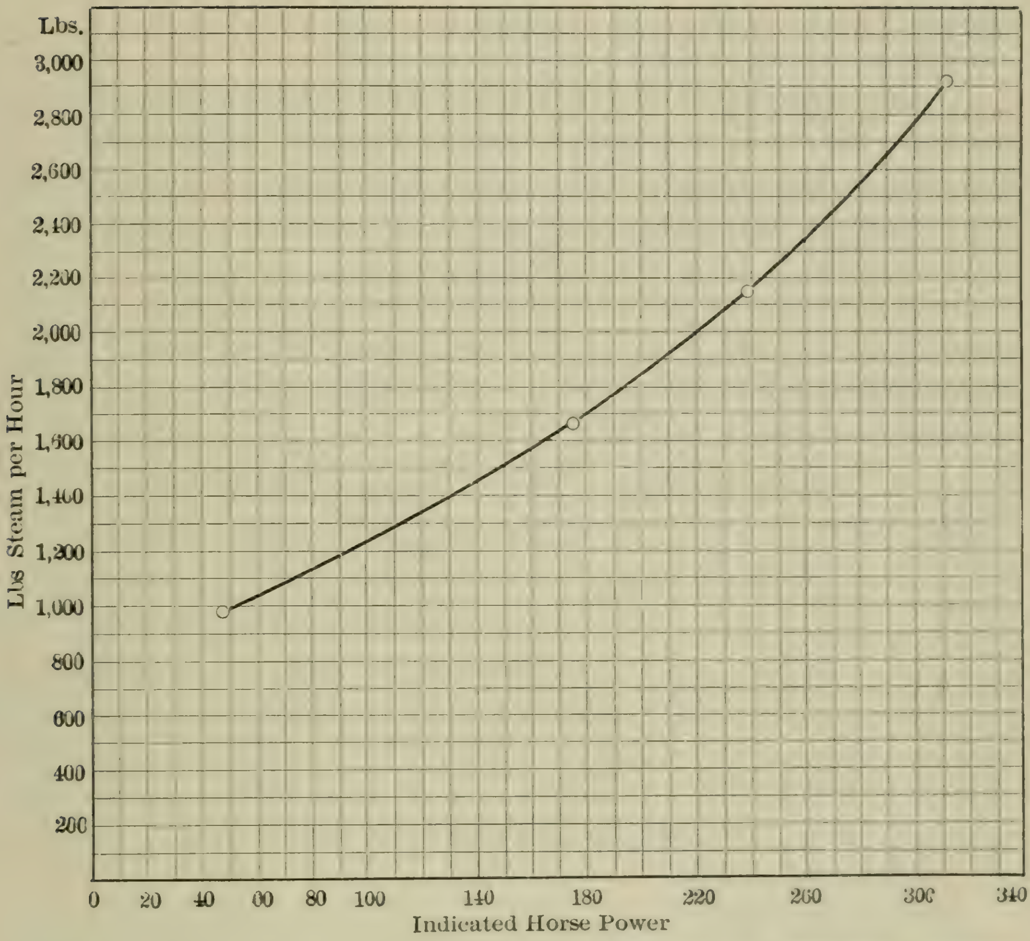

FIG. 5. TOTAL STEAM CONSUMPTION OF 300-HORSE-POWER COMPOUND ENGINE USING SUPERHEATED STEAM.

can be expected from figures giving the reduction in steam consumption is to find the number of thermal units in one pound of the superheated steam and subtract from this the number of thermal units in one pound of the feed water. Then find the number of thermal units in one pound of the saturated steam and subtract from this the number of thermal units in one pound of the feed water. The ratio ot these results is the ratio of the coal consumption per pound of steam in the two cases, if the efficiency of the boiler and superheater in the one case is equal to the efficiency of the superheater in the other case. If, therefore, we multiply this ratio by the ratio of steam consumption per horse-power in the two cases, we get the ratio of coal consumption in the two cases. This means of getting at the relative coal consumptions involves the assumption that the efficiency of the boiler in the case of the saturated steam is equal to the efficiency of the boiler and superheater in the case of the superheated steam. These efficiencies, of course, may not always be the same. In the test of a Lancashire boiler and Schmidt superheater by Prof. Ewing, the efficiency of the boiler alone was 70 per cent., and that of the combined boiler and superheater only 63 per cent.*

If the superheating tubes are heated by the hot gases passing from the boiler to the chimney, which, when the superheater is not in use, pass direct to the chimney, then the efficiency of the boiler and superheater will probably be greater than the efficiency of the boiler alone when the superheater is not in use.

When comparing the best results to be obtained with saturated steam with the best to be obtained with superheated steam, it must be remembered that if we use no superheater we can often employ a feed-water heater which can utilize a considerable portion of the heat of the gases leaving the boiler and send the gases away at a low temperature; whereas, if the gases leaving the boiler have to heat a superheater, they cannot in most cases be used for a feed-water heater. Now the temperature of the waste gases cannot be lowered below the lowest temperature of the fluid being heated, whether this is steam or water; and the temperature of the steam entering the superheater is obviously greater than the temperature of the water entering the feed-water heater. Therefore the waste gases must pass away at a higher temperature when a superheater is employed than would otherwise be necessary, and therefore more heat and more coal will probably be wasted.

On the other hand, it must be remembered that the use of a superheater does not necessarily prevent the use of a feed-water heater. With a boiler designed for no superheater, it ought to be impossible to heat both a feed-water heater and a superheater with the gases leaving the boiler; if it *is* possible, then the boiler has been very badly designed for its work without the superheater. But if a feed-water heater and a superheater are decided on at the start, there should be no difficulty in so designing and arranging the boiler, superheater, and feed-water heater, that all can obtain sufficient heat and the waste gases pass away at a minimum temperature.

There is a good deal of discrepancy in the results given in Tables III and VI, and there are various reasons for this. The dryness fraction of the saturated steam probably differed very considerably in the several cases and the engines were of different types and different sizes. It must be noted that an engine constructed to give the best results with saturated steam is usually unsuitable for use with highly superheated steam, and an engine designed for using highly superheated steam does not usually do justice to saturated steam. Steam turbines seem to have an advantage over reciprocating engines in this respect. Steam turbines of the Parsons type can be built to stand a superheat of about 150 degrees F, (steam pressure 150 to 200 pounds per square inch) without any appreciable addition to their cost and without lowering their efficiency when using saturated steam to more than a very slight extent.

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* This refers to the same test as Tables VI and VII. The efficiencies of boiler and superheater were not given by Prof. Ewing in his report but have been worked out by the writer from figures given by Prof. Ewing. The low efficiency of the superheater may have been due to its never working at more than half load during any test.

As regards the life of superheaters, evidence is very conflicting. This is to be expected, as the life of a superheater must necessarily depend largely on its design and on the arrangements used for heating it. There seems no reason why a well designed and well arranged superheater should not last as long as a water-tube boiler.

As regards cost of piping for superheated and saturated steam, it should be noted that, although the volume of superheated steam is greater than that of saturated steam, the superheated steam experiences less friction in passing along pipes; and it is therefore possible with the same pipe and the same loss of pressure, to give superheated steam a higher velocity than saturated steam. As a less weight of superheated steam than saturated steam is required per horsepower hour at the engine, the same pipe will convey with a given loss of pressure at least as much power (measured at the engine) in superheated steam as in saturated steam.

To sum up the gains and losses to be expected by adopting superheating, these are—

Losses.

1. Initial cost and upkeep of superheater.
2. Increased initial cost and upkeep of engines.

Gain.

Reduced coal consumption.

If, with 150 degrees F. of superheat, the coal consumption be reduced from 1.5 pounds to 1.275 pounds per brake-horse-power per hour, that is 15 per cent., the gain with an engine of 1,000 brake-horse-power working 2,500 full power hours per year will be 251 tons. With a good design and arrangement of superheater and a suitable engine, this gain ought easily to wipe out the losses due to the interest on the increased cost of the plant and the increased depreciation and cost of upkeep, and leave a substantial balance of net saving.

In conclusion, I would express the opinion that there is no doubt that with properly designed plant superheating pays. What is the best paying superheat is, however, a question which it seems impossible to answer with any degree of accuracy with the data at present at our disposal.

PRACTICAL INVESTIGATIONS IN THE GAS-TURBINE PROBLEM.

By Charles E. Lucke, Ph. D.

The gas turbine has been regarded as the logical successor of the steam turbine, and already numerous devices have been produced, on paper, to convert the energy of the confined products of combustion into mechanical power. Dr. Lucke examines the thermodynamic principles involved in such devices, and shows, as the result of exhaustive experiments, conducted in the mechanical laboratory of Columbia University, that this conversion is not effected by free expansion in simple nozzles. A portion of the potential kinetic energy developed by the combustion, and readily transformed into work when the products of this combustion are allowed to expand in the cylinder of a reciprocating engine, is not so recovered when these same products expand through the nozzles of an ordinary turbine; and the difference is so great as to make the latter a failure commercially. This Dr. Lucke considers the answer to the question, and it is as definite as it is unfavorable. It refers, of course, wholly to the gas turbine. The investigations do not cover a mixture of combustion gases and steam. An examination of the principles of free expansion, as discussed in this paper, will go far to prevent mistaken claims from receiving unwarranted support, and to direct the work of engineers and inventors into those channels in which success is more probable.—The Editors.

AN engine carrying a rotating part, provided with vanes or buckets on which a jet of fluid may impinge to cause rotation, is in brief a turbine. When water is the fluid, custom has sanctioned a somewhat different classification. The bucket wheels of Pelton and Doble have seldom been called turbines, yet they are more truly turbines than some other water wheels that have received the name. In these, water under pressure issues from a nozzle into the atmosphere, thus converting pressure head into velocity, giving outside the nozzle a mass of water with no pressure but moving with high velocity. By contact with the buckets, the water is brought to rest and the bucket moved with force enough to overcome some resistance.

This receiving of a jet of fluid and bringing it to rest is the function of the rotating part of every turbine, and work is done by this member only because it can bring to rest the jet of fluid once formed with a given velocity. Velocity is given to any fluid, liquid vapor, or perfect gas, by forcing it to flow through an orifice or nozzle from a place of high pressure to one of low pressure. This process, whereby the fluid is given a velocity by a pressure drop through an orifice, is very thoroughly understood for incompressible fluids such as water, where there is no change in density and hence no expansion of the mass with the change of pressure. Should, however, the fluid be a perfect gas, it will change density with the pressure change and suffer an expansion in addition to the phenomena apparent in constant-density fluids. Such expansion through a nozzle is termed "free expansion."

The laws governing change of state in the fluid by free expansion are but little understood, and nearly all computations that have been made thus far have involved some assumption not experimentally verified. To the two previous cases (involving the velocity due to pressure drop of a constant-density fluid, and the change of density due to the same pressure drop), free expansion of a vapor adds an additional phenomenon—that of partial condensation, or possible superheat. Flow of fluids then presents three sets of phenomena.

Liquids.

1.—Velocity due to pressure drop, with density constant and constancy of liquid state.

Perfect Gases.

1.—Velocity due to pressure drop, with density constant.

2.—Velocity due to change of density as resultant of pressure and temperature change.

Vapors.

1.—Velocity due to pressure drop, with density constant.

2.—Velocity due to change of density as a resultant of change of pressure with the vapor remaining as vapor.

3.—Velocity due to change of state, from vapor becoming partially superheated or partially condensed.

These phenomena may be divided into (a) purely mechanical action, and (b) thermal action. The first increment of velocity, due to pressure drop with constancy of density, is a purely mechanical change; while the other two increments, due to change of density or change of state, are thermal.

The last may be a positive increment, or negative—that is, velocity may be increased or decreased as the result of this action. The extent of the change of density in free expansion, and the amount of superheat or condensation, are dependent on the thermal characteristics of the fluid. As the kinetic energy of the resulting jet is due to all three velocity increments for a unit mass flowing, that part of the resultant kinetic energy that is due to free expansion of a perfect gas or vapor is also dependent on the thermal characteristics of the fluid. This particular part of kinetic energy of the jet is the measure of, or is measured by, the amount of heat that has been given up by the fluid to give the mass the velocity increment due to free expansion.

The amount of heat that is transformed into work by a pressure-volume-temperature change in a perfect gas or vapor, can be known when the total heats of the fluid before free expansion and after, while still possessed of its velocity, are known, or when the law of pressure-volume-temperature change is known. Therefore positive information must be available on the above phenomena in order to know the kinetic energy or velocity and mass of the fluid in motion, and hence the work that might be done by the transfer of velocity and kinetic energy to the wheel.

The turbine engine, using expanding fluids such as steam or a perfect gas, may be said to depend for its possibilities of output and efficiency on, first, a mechanical action in the jet, and second a thermal action. The latter may be absent. The turbine may convert both potential mechanical and thermal energy into work, or only the first. No matter how perfect may be the mechanism for changing the energy of the jet into energy of the wheel, the turbine may be useless if the maximum amount of original energy of the fluid is not first converted into kinetic energy of the jet. In other words, if the designer's knowledge of free expansion is not sufficient, it may be impossible to provide means for utilizing the possibilities of the basic free-expansion phenomena in giving to the jet of fluid the maximum possible kinetic energy.

The mechanism so far used for conversion of the original potential energy of the fluid into kinetic energy of jet is the nozzle. These nozzles may be simply holes in plates of circular, rectangular, or any cross section, of any length and any degree of change in area of cross section. Practically all nozzles that have been used were designed on some assumption of the phenomena taking place in free expansion, because there is not in existence sufficient experimentally verified information to permit of a more positive method.

When the fluid used is a perfect gas, or nearly so, such as air or the gaseous products of a combustion, the turbine comes under the head of gas turbines. More particularly is the name applied to those turbines using the products of combustion from a fuel and air previously compressed. The actual mechanism of these gas turbines may cover a great range of varieties, but there are three elements to the system:—(a) A compression pump for air and fuel. (b) A receiver for the fuel and air compressed, and pressure combustion chamber to convert the fuel and air into hot gas. (c) The turbine proper to use the hot gases.

While of course the efficiency of the system, measured by the ratio of the net horse-power output to the horse power equivalent to the heat supplied, will depend on the efficiency of the compressor and the turbine, it is dependent primarily on the efficiency of conversion of the heat of the hot gases from the fire to kinetic energy of these same gases after the expansion. If the means for executing free expansion, perchance by a simple nozzle, be such that much of the heat of the originally hot gases can become kinetic energy of the jet, the gas turbine may be good; otherwise it cannot, be the refinements of the rest of the mechanism as fine as they may.

For this heat conversion to be good, the temperature of the hot gases must be lowered in acquiring velocity; and conversely, if the temperature of the jet in motion be but little lower than that of the gases leaving the fire, the free expansion has not converted much of the fuel heat into work. Expansion in a cylinder behind a piston is termed balanced expansion, because the pressure of the gas is always balanced by a piston resistance and the mass is practically at rest. It is well-known that such balanced expansion will cool the gases, and by this cooling heat is converted into work. The computation of the amount of heat thus transformed into work is easy for balanced expansion as the problem is quite definite.

Should the temperature drop due to free expansion of the hot gases be less than that for balanced expansion, then less heat has been transformed into work, or kinetic energy. It is here that most of the propositions for operating gas turbines have involved a serious assumption. It has been taken for granted that by free expansion in a nozzle, the temperature drop would be the same as for expansion behind a piston, though no experimental verification is available.

Should it be possible to bring about a temperature drop by free expansion equal to that for balanced expansion, then the possible thermal efficiency of the gas turbine would be the same as for a corresponding gas engine—other losses in compression, jacketing, friction, etc., being equal. It is on the assumption of the truth of the above that all the predictions so frequently heard of the possible future of the gas turbine are based. Unfortunately, the experiments to determine just how to produce equivalent results by free and balanced expansion have been by far less numerous than the reiteration of statements that such equivalence must exist.

It is not within the scope of this paper to examine whether or not theoretically such equivalence can exist, nor to determine the conditions of equivalence; but a few of the experimental facts bearing on this question will serve the present purpose. Inventors of ice machines have met this problem in their work. One style of ice machine compresses air, cools it after compression to the temperature of whatever water is available, and subsequently expands the air in cylinders. The exhaust from these cylinders, for even moderate initial pressures, is cold enough to freeze water. By such balanced expansion a cooling results that is found to agree very well with that theoretically computed on an assumed law—and verifying the law, as the discrepancies are easily accounted for. This mechanism of the second or expanding cylinder is complicated and inventors have sought to substitute for it a simple nozzle to use free expansion in place of balanced expansion, assuming equivalence of results. This attempt has met with total failure, as practically no cooling has been attained, the air after passing the nozzle being only a few degrees colder than before passing. It might be urged that this is explained by the fact that the air in the system, by impact, loses its velocity and so suffers a rise equal to the temperature drop it suffered in acquiring velocity, with a slight difference due to the fact that the gas is not perfect. While there is an element of truth in this, it does not account for the whole difference observed, because water cannot be made to freeze on the nozzle itself, with air that easily freezes water on the exhaust pipe of the air cylinder operating under balanced expansion.

Holding a thermometer in the stream of air issuing from an open valve or nozzle on a compressed-air main will show, for even a pressure drop of 100-pounds per square-inch, only three or four degrees temperature change. This also may be due to impact on the thermometer raising the temperature of the moving gases by bringing them to rest on the bulb; but again this will not account for the whole difference between what is observed and what would be were this free expansion equivalent to balanced expansion. To eliminate the errors of impact as much as possible, a thermal couple stretched axially along the jet and made of fine wire has been used by the author for a measurement of the temperature of the air when moving at the maximum velocity. The maximum temperature drop for air under 100-pounds initial pressure, expanding through a steam-turbine nozzle into atmosphere, is only 30 degrees F. This result is only 12 per cent. of the temperature drop that would have resulted did the air suffer balanced expansion without gain or loss of heat.

Another instance of the same lack of equivalence in results by free and balanced expansion is found in the experiments of Tripler and Linde on the making of liquid air. In this work air highly compressed (2,000 to 3,000 pounds per square inch) is first cooled by water and then some of the air freely expanded through a hole, the discharge passing around the pipe feeding the hole. This was intended to cool the air in the pipe lower than the critical temperature for liquification under the high pressure used. The results were enormously different from the case for balance expansion, the temperature drop through the nozzle being only about ¼ degree F. per atmosphere-pressure drop, according to one report. More accurately, the results for the Linde process are shown in the following table, the initial pressure being 220 atmospheres.

Temperature approaching the nozzle.	Actual temperature drop through nozzle.
+ 30° F.	35° F.
0° F.	65° F.
— 30° F.	80° F.
— 60° F.	96° F.
— 100° F.	112° F.
— 150° F.	135° F.

Unless, by an increase of knowledge of free expansion of perfect gases, it becomes possible to produce results equivalent to those obtained with balanced expansion, there cannot be the same amount of heat transformed into work by the gas-turbine engine as by the cylinder-and-piston gas engine.

In conclusion, the situation may be summed up by saying that so far no work has been done that warrants any assumption of equivalence, and the difference is so great that the pure gas turbine, provided with the simple nozzles used by steam turbines, is a failure commercially, and can never rise above this until some method has been found to make results by free expansion more nearly equal to those obtained in cylinders.

EDITORIAL COMMENT

WITH the announcement of the successful meeting of the two headings of the Simplon tunnel, on February 24, attention may well be directed toward the changes and modifications which the opening of the new route is expected to effect. Naturally, the thrifty Swiss are looking for many important opportunities for the further exploitation of that supply of natural scenery which constitutes so large a proportion of their stock in trade, and the tourist traffic and the development of hotel sites will form no small portion of the return which the mountain republic will receive for the outlay which it has made upon the enterprise.

The great importance of the tunnel, however, lies in the effect which it will have upon railway connections between Italy and the sea, and these will bear a brief examination. With the opening of the Simplon-Jura connection to the Italian railway system there will be available for purposes of commerce five different methods of reaching Italy by land. By the Semmering Pass Vienna is connected with Venice, while Innsbruck and Verona are united by the railway over the Brenner Pass. The St. Gothard route, with its famous tunnel, runs from Milan to Lucerne, while the Mont Cenis railway and tunnel enable direct connection to be made from Turin to France without passing through Switzerland at all. The extension of the Simplon-Jura railway up the Rhone valley, through the Simplon tunnel to Iselle and Domo d'Ossola, gives direct communication from Geneva and Lausanne to Novara and Genoa.

The Semmering and the Brenner routes give ample communication with Austria; the Mont Cenis line is wholly French, while the St. Gothard serves its original purpose by enabling Italy to reach the North Sea by way of Germany, Holland, and Belgium, and the ports of Hamburg, Amsterdam, and Antwerp. At the time the Simplon project was launched there was insufficient attention given to its effects in France, but it has become evident that the advantages of the lower altitude—2,300 feet as against 3,800 for the St. Gothard, and 4,200 for the Mont Cenis—as well as the reduction in distance, will divert the traffic to Calais and to Ostend, and undoubtedly affect the commerce of Marseilles. By the existing connections the distance from Milan to Calais is 712 miles by the St. Gothard, while it will be only a few miles less with the present connections, but the time will be materially reduced by reason of the lower grades. When, however, the Vallorbes tunnel is pierced, the distance from Milan to Paris by way of Lausanne and Pontarlier will be reduced from 556 miles to 518 miles, and it will be possible to reduce the time between the two cities to 14 hours.

Another route, by way of Lons-le-Saunier and the Col de la Faucille, has been proposed, but the advantages which it offers are partially offset by by the fact that it would require the piercing of several comparatively long tunnels. It has also been suggested that a direct connection across France to the Atlantic coast might be arranged by combining existing railways, a suitable port being that of St. Nazaire, at the mouth of the Loire, this giving a great advantage over the North Sea ports of Hamburg, Bremen, and Antwerp for Transatlantic commerce.

There is no doubt that Genoa will be greatly benefited by the opening of the new line in any case, while the whole of the Jura-Simplon connections in Switzerland, including Geneva, Lausanne and the Rhone valley towns will also be the gainers. Through traffic will find the new route preferable to that over the St. Gothard, and if the proper connecting lines are built France should gain more by the traffic to the North Sea and the Atlantic than she loses at Marseilles. The experience with the past shows that there has been a sufficient increase in business to keep old and new routes busy, and there is every reason to believe that neither the Mont Cenis nor the St. Gothard will lose much, since the new route will operate to create new traffic in addition to the old.

* * *

DR. BELL, whose leading article in this issue is full of most interesting suggestion, well says in his introduction that "the subject of civilization is human development—all the rest is accidence." Modern achievements are valuable only by "their effect upon the growth of humankind, and the evolution of a sounder society." But he shows that in the case of an achievement so apparently technical even as the distribution of electricity, the direct influence upon environment, opportunity, and social conditions is most immediate and of vast possibility. Similar results, in varying degree, attend almost all the great applications of science which make up the work of the engineer. It would seem that the man who undertakes to keep generally informed as to the work and progress of the world should have some kind of a chart of the main points of engineering accomplishment—what is being done, at least, though not necessarily *how* it is done. Yet which of the periodicals professing to keep its readers in touch with all human affairs attemps this?

The past few weeks have been unusually full of engineering event or achievement of a kind which is widely interesting because it is the foundation for broad developments in industry, commerce, finance, and politics. But of the two principal illustrated monthly reviews, the one devoted primarily to periodical literature selects, from all the engineering field, a minor application of electric traction to omnibuses on common roads—fully covered, by the way, in the Continental papers and in THE ENGINEERING MAGAZINE nearly two years ago—while the one professedly devoted primarily to action finds, in the whole range of engineering, nothing at all to note.

However, it is not very many years since the complete education of a gentleman included scarcely more than the classics. Perhaps after another generation the idea may prevail that the well-informed man of affairs should have put before him some kind of an intelligent summing-up of the physical progress of civilization—not in the manner of the kindergarten, nor of the melodrama, but sanely and plainly.

* * *

ONE or two large engineering undertakings have been much discussed lately, and have served to fix attention upon the vast expenditures involved in such work—expenditures more than justified, in well-considered ventures, by the proportionate wealth-earning or wealth-saving power of the completed work, or by its contributory influence in the general development of industry and commerce and the betterment of social conditions.

The aggregate of the larger engineering propositions now actively under way in this country is, however, almost overwhelming. Limiting the list to Greater New York alone (that is, to the subway, tunnel, bridge, terminal, and water-supply work certain to be completed within a very few years), the total is close to $500,000,000—figures that would have staggered the world not long ago. And yet the undertakings are launched, and financed, and carried through to success with far greater ease than attended the execution of works one-tenth the size, within the easy memory of men still in active life. We seem to deal with hundreds of millions as easily almost as we handled single millions twenty-five years ago. The underlying causes and the future bearings of this vast prosperity will be most strikingly pointed out in a forthcoming series of articles in this Magazine. For the present, there is the welcome certainty of years of profit and expansion in the engineering industries and in all lines of manufacture turning out engineering material.

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THE extent to which labor is saved and the time of mechanical operations is shortened by the use of modern appliances may be well illustrated by an example taken from recent work at the New York Navy Yard. Since the article on shipyard cranes was written by Lieut. Shultz, published elsewhere in this issue, the floating crane Hercules was called upon to place the heavy guns on board the battle-ship Indiana, which has been undergoing repairs and overhauling. This work was accomplished in the short space of four and a quarter hours. When it is realized that there were four guns, each weighing 75 tons, the length of a gun being 39 feet and the breech-diameter four feet, the efficiency and labor-saving value of the machine will be appreciated better.

* * *

IT is significant (and to us very welcome) to note that "Production Engineering" is now receiving definite recognition as a distinct branch of applied science, and that several of the technical schools are giving it a larger or smaller place in their engineering courses—not always with the adequacy of conception or the distinctness of formulation which it deserves, but at least with an acknowledgment of the importance of certain of its elements to the successful practice of modern engineering.

The situation, in our view, is not unlike that in which electrical engineering was placed some twenty years ago. Many conservative institutions, if it had then been suggested to them to create a new department in the electrical field, would have replied that they were already covering the subject in their course in physics. In a sense, the reply would have been correct; they were teaching the science as it had long been understood; but it had just entered into a vast new field of application, demanding new methods of attack, and the schools of applied science which took the initiative in establishing a chair of electrical engineering soon found it requisite to expand the course into a department—and by no means the least important in their curriculum.

Something similar, apparently, is likely to occur in the elevation of production engineering into a separate, clearly defined technical course. The difficulties in its way are great; the pressure on the time of the college year is already heavy, and the financial resources of almost all the universities are overtaxed as it is. But the former point could doubtless be met by a definite specialization in the new course during the student's last year; and as to the latter—the subject is certainly one which, by its absolute business common sense, should appeal, as worthy of endowment, to some successful man of affairs who has himself seen the profitable results of this most practical of all applied sciences.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

BRITISH COAL SUPPLIES.

THE EXTENT, AVAILABLE RESOURCES, AND RATE OF EXHAUSTION OF THE COAL FIELDS OF THE UNITED KINGDOM.

Report of the Royal Commission.

SEVERAL years ago a Royal Commission was appointed to inquire into the broad question of the condition and probable duration of British coal supplies. This commission, composed of a number of eminent engineers and economists, has made interim reports from time to time, and now the final report has been made public. In considering this important subject the report is divided into a number of headings, treating of the resources of the British coal fields, and their probable duration; possible economies which may be effected; the effect of the export of coal on British consumers and on the navy; and the maintenance, under existing conditions, of the competitive power of British mining industries with the coal fields of other countries.

Accepting 4,000 feet as the limit of practicable depth in working, and taking one foot as the minimum working thickness, it is estimated that the available quantity of coal in the proved coal fields of Great Britain is about one hundred thousand million tons. Nearly 80 per cent. of this is in seams of two feet thick and upwards, and 91 per cent. is in seams of 18 inches thick and upwards.

In addition to the coal within 4.000 feet of the surface, there is a considerable quantity in the lower levels, this being estimated at more than five thousand million tons, but whether or not this is recoverable depends upon the depth at which it may be found practicable to carry on mining operations. There are a number of collieries, notably in Belgium, where seams are being worked at depths in excess of 3,000 feet, but, so far as is known, there are no seams at present worked at depths exceeding 4,000 feet, and there are no insuperable engineering or mechanical difficulties indicated in connection with such deeper workings. On the Continent the limit of working has been placed at 1,500 metres, or about 4,900 feet, so that the limits set by the commission at 4,000 feet is entirely within the judgment of present practice.

So far as the thickness of seams is concerned, the thicker seams are naturally worked first, but during the year 1900 it is estimated that nearly 18 per cent. of the total output of the United Kingdom was obtained from seams of less than 3 feet thick. The introduction of coal cutting machines may be expected to enable seams to be worked successfully which could not otherwise be utilized, and this is a point of especial importance.

The important question of the probable duration of British coal resources depends chiefly upon the rate of the annual output. At the present time the annual output is 230 million tons, and for the past thirty years the average increase has been 2½ per cent. per annum, while the increase in exports, including bunkers, has been 4½ per cent. per annum. It is believed, however, that the rate of increase has about reached the maximum, and that the rate of increase of output may soon be expected to become slower, followed by a period of stationary output, and then by a gradual decline.

The introduction of machinery, both for coal cutting and for handling, has been very fully considered by the commission, and there appears to be no doubt that such appliances are to be recommended, due regard being had to the conditions of each case under consideration.

The opinions of the commission with regard to the manufacture of coke, and the use of briquettes is of especial interest.

"In the industry of the manufacture of coke by far the most important step in recent times has been the introduction of the bye-product recovery ovens. The prejudice against coke made in these ovens lasted long, but is being gradually overcome. It is found that by careful quenching, the difficulty as to colour can be to a large extent obviated, while chemical analysis and practical experience show little or no difference between the coke made in these and other forms of oven. That there is still a large margin for the further introduction of these recovery ovens is shown by the fact that in 1902 only 10 per cent. of the total output of coke was obtained from them.

"The production of coke as it is extensively carried on in this country, without full utilisation of the volatile products, is condemned by all the witnesses. In the best modern practice these products are either burnt in flues round the ovens, or are separated by cooling into liquids and gases, the latter of which are used for heating the ovens themselves. The surplus gas can be used for the production of power under steam boilers, or with greater advantage in gas engines. Coke oven gas is a rich gas, approximating to illuminating, and far richer than producer gas.

"The importance of the extended adoption of coking cannot be exaggerated. It is one of the methods by which small coal can be rendered marketable, and in some districts it has reduced the waste by furnishing the collieries with an outlet for the small coal, without which outlet it is doubtful whether they could have been carried on.

"Hitherto the manufacture of briquettes has been mainly confined to South Wales, where the small coal made in the screening and in the transit of the best steam coal, is mixed with 8 to 10 per cent. of pitch and converted into briquettes. Large quantities of similar small steam coal are exported to the Continent for the same purpose. Of the value of these briquettes as a fuel there is no doubt, and they are extensively purchased by the Royal Navy as a reserve stock in hot climates, where they are said to deteriorate less than Welsh coal. In England and Scotland briquettes are seldom made, probably because there is a good market for small coal. There is, however, every reason to anticipate that in the future they will be more largely used for steam and domestic purposes, and there appears to be a good field for the discovery of a suitable binding material—pitch, which is the chief binder used at present, being rather too smoky for domestic purposes, and also high in price.

"The evidence points to the conclusion that a suitable briquette plant, if well managed, should pay in connection with a colliery; at present the briquette factories in this country are mostly situated at, or near, docks. Suggestions have been made that partial distillation, in addition to washing and cleaning, would give a much wider choice of material for the manufacture of first-class briquettes, and that coal and oil might be used in combination so as to form briquettes of good calorific value out of inferior coal."

That coal is wastefully used at the present time is a matter concerning which there is little difference of opinion. From the most reliable statistics at present available it is gathered that the consumption of coal for the year 1903 was 167 million tons, and of this great consumption it has been computed that there is a possible saving of 40 to 60 million tons, or about one-fourth.

The principal source of economy in the use of coal appears to be in the conversion to gas, and the utilization in internal-combustion motors, as well as in the saving and utilization of the gas now produced in metallurgical operations. Since much more gas is produced by blast furnaces than can be advantageously used in the works, it has been suggested that the electrical distribution of power from such centres would enable a large amount of energy to be replaced which is at present produced by the direct consumption of coal.

So far as liquid fuel is concerned, it is believed that, while it is of much value and service for special purposes, that it cannot be considered as a serious means of replacing coal to any extent. There is no real substitute at present in sight, and coal is the only reliable source of power, these other sources providing only some slight relief in the demand for coal.

A material saving in the use of coal may be anticipated by the establishment of central stations for the generation and production of power in bulk.

"Hitherto, nearly all such stations in this country have been worked by steam power, and although there are a few gas-engine stations, it is stated that they do not compare favourably with steam-engine stations in practice. It is admitted, however, that gas engines ought to, and will in future, displace the reciprocating steam engine for driving dynamos for large power.

"Dr. Hopkinson has made an interesting comparison between steam plants and gas plants for central power stations. After giving detailed figures he sums up in this way:—'Hence it appears that such a central station as has been described, if equipped with gas plant, will involve a capital outlay approximately the same as with steam plant, and that the fuel consumption, if worked at full load continuously, will be reduced in the proportion of 100 to 83, and if with a load factor of 25 per cent., in the proportion of 100 to 35. These figures only represent the actual saving in fuel. The economy in the money cost of fuel is much greater, owing to the fact that coal can be used in the producers, which can be supplied at less cost than coal for use in the steam boilers, proportionately to its calorific value, and also to the fact that the recovery of the ammonia may be taken as a direct saving in fuel cost, equal, in the case of coal used in the producers worth 7s. per ton, to a saving of 4s. 6d. per ton at the present price of ammonium sulphate.'"

An important matter is the supply of suitable coal for the use of the navy, certain qualities, such as calorific efficiency, smokelessness, cleanness, hardness, free burning, minimum of ash and clinker, and freedom from caking or trouble in stoking being demanded.

"Experiments are constantly being made with different coals, with mixtures of coals or coal and oil, and with various appliances, and, generally speaking, the Admiralty are trying in every way to extend their sources of supply, but so far, it is said, no fuel has been found equal to Welsh coal for naval purposes. In this connection, however, it is interesting to note the increasing and economic use in the mercantile marine of other and cheaper grades of coal and of small or mixed coals, which has been rendered possible by the employment of improved boilers and furnaces.

"In recent years many experiments have been made in the Navy with oil fuel, and the results are said to be promising, but the uncertainty of obtaining an adequate and regular supply must always be a serious objection to the substitution on a large scale of oil fuel for coal. There seems, however, reason to believe that in the future oil fuel will be used for auxiliary purposes in men-of-war, and internal combustion engines working with volatile oils have been successfully introduced for the propulsion of small vessels. There is also the proposal to apply gas producers and internal combustion engines on board ship, and these being smokeless will tend, if successful, to lessen the use of high-class Welsh steam coal. Whatever be the outcome of these experiments, the evidence shows that in the opinion of the advisers of the Admiralty it is necessary, under present conditions, to coal the ships of the Navy with the best steam coal."

Broadly, the report leaves matters in a condition which is hardly reassuring as to the future, but not alarming as to the present. There is enough coal for the present generation and for those which are to follow it immediately. As for those who are to come three or four hundred years after us, but little can be said. They must solve their own problems for themselves, and certainly we cannot settle them at this date. Possibly they will look back upon these deliberations with an amused complacency, in the knowledge of other sources of energy which shall have then been discovered, and in any case they must be left to work out their own salvation with the means and appliances at their command, regardless of what may have been done by their predecessors.

THE ECONOMY OF SUPERHEATED STEAM.

DATA AND RESULTS OF THE LATEST TESTS OF COMPOUND SUPERHEATED-STEAM ENGINES IN GERMANY.

M. F. Gutermuth—Verein Deutscher Ingenieure.

IT has now become generally recognized that the only way in which the steam engine can compete in thermal efficiency with the internal-combustion engine is by so modifying the operative fluid that it shall practically become a permanent gas, within the limits of temperature change employed, and thus prevent the losses which follow from internal condensation. In other words, a fluid which is used at or near its critical point cannot be expected to enable as high an efficiency to be secured as is possible with one in which no change of state can be produced. In the case of the gas engine the problem is comparatively simple, but with the steam engine the fact that the gaseous steam may be more or less converted into the liquid state during the working cycle, introduces sources of loss which have been the study of engineers ever since the days of Watt.

At the present time the best method of preventing the losses due to cylinder condensation is generally accepted to be the superheating of the steam. Multiple-expansion has been carried to its limit for the initial pressures which have been found practicable, and about all that can be expected has been realized from that expedient. Steam jacketing is but a palliative, and hence it has been found that the next, and apparently the only means to improve steam economy is to convert the steam into what is practically a gas, by giving it such a degree of heat beyond the temperature due to its pressure that no conversion to the liquid state shall be possible during the time it is undergoing expansion in the cylinders of the engine. The latest experiments which have been made upon engines using superheated steam have been those upon machines of the so-called semi-portable type, built by Wolf, of Magdeburg, and from a very complete analysis of such tests, made by Professer Gutermuth, of Darmstadt, and published in the *Zeitschrift des Vereines Deutscher Ingenieure,* we make some abstract, as being of very general interest and importance.

Two different types of semi-portable engine are described by Professor Gutermuth. the difference being mainly in the arrangement of the cylinders, one being a tandem and the other a cross-compound, while comparative trials were also made on a simple engine of similar general construction.

The boiler used with the Wolf engines is a modified form of locomotive boiler, having a cylindrical corrugated firebox, short straight tubes, and a long extension smoke box in which the superheater is placed. The superheater is formed of a helix, or rather a series of helices, the whole forming an endless coiled pipe, the steam from the boiler passing through the successive coils and then directly to the engine, which latter is mounted on top of the boiler shell in the manner usual with portable and semi-portable engines.

The engine had cylinders of 285.9 mm. and 540.9 mm. diameter, and 570 mm. stroke, giving a ratio of 3.65 to 1, the power being 200 h.p. at 155 revolutions per minute. The cranks were set opposite each other, and both cylinders were fitted with piston valves, regulation being effected by a shaft governor connected to the valve of the high-pressure cylinder.

The boiler had 48.55 square metres heating surface, and 1.18 metres grate surface, giving a ratio of 41 to 1, while the superheater had 32 square metres heating surface. Five series of tests were made, each ranging from four to five hours duration and with various degrees of superheating, the performances of the engine and the boiler being very fully tabulated and analyzed in the paper by Professor Gutermuth. To these tabulated results the reader must be referred for details, but the results, so far as steam consumption may be given here. With initial steam pressure of 11.8 atmospheres, or 173.4 pounds per square inch, and a vacuum of 90 per cent., the steam consumption per horse-power-hour was as follows: at 78° C. superheat, 4.91 kilogrammes (10.8 pounds); at 122° C. superheat, 4.71 kilogrammes (10.35 pounds); and at 142° C. superheat, 4.625 kilogrammes (10.17 pounds). The coal consumption per horse-power hour for these same tests was 1.38, 1.36, and 1.36 pounds respectively, the coal containing 7.11 per cent. of ash, and giving, by analysis and the *Verband* formula, a calorific value of 13,650 B.T.U.

This, is certainly an excellent showing, especially for an engine of such a moderate size, the thermal efficiency working out at a little over 19 per cent., which is approaching quite closely to that of some of the smaller gas engines. Doubtless a part of the good performance is to be found in the manner in which the superheat steam passed directly to the high-pressure cylinder from the superheater, there being practically no opportunity for condensation losses. Professor Gutermuth analyzes the performance, both by the comparison of the combined indicator diagrams with the theoretical card, and also by the temperature-entropy analysis, and the whole paper forms an excellent study of the conversion of heat into mechanical energy.

In the case of the tandem compound engine, of the same makers, the dimensions were smaller, the cylinders being of 160 and 200 mm. diameter respectively, giving a ratio of 3.57 to 1, developing from 50 to 60 horse power. In this case, besides the initial superheating of the steam, there was a reheating of the steam between the two cylinders, and notwithstanding the smaller size of the machine the performance was somewhat better. With 87° C. superheat, upon an initial pressure of 12 atmospheres, or 176 pounds, and a vacuum of 90 per cent., the steam consumption per horse-power-hour was 4.36 kilogrammes, or only 9.6 pounds!

These tests show the distinct economy which may be obtained by superheating, but they also show that there is a limit beyond which little or no gain is secured. Thus the performance at 142° superheat was but a trifle better than at 122°. In the case of the tandem compound engine, with interheater the performance was better at 87° superheat than with the larger engine at 142°. It is probable that superheating is of value in so far as it counteracts cylinder condensation, but that so soon as the temperature which will prevent internal condensation is passed there is little or no gain in economy by increase in temperature.

THE ELASTICITY OF REINFORCED CONCRETE.

A DISCUSSION OF THE MANNER IN WHICH METALLIC REINFORCEMENTS ENABLE CONCRETE MEMBERS TO SUSTAIN GREAT ELONGATION.

A. Considère—Comptes Rendus.

IT is well known that ordinary concrete, while possessing great resistance to compressive stresses, yields to much smaller forces acting in tension. For this reason concrete has, until recently, been employed in compression only, and not until the methods of imbedding reinforcing elements of metal were introduced, has it been considered advisable to permit concrete structures to be subjected in any part to tensile stresses. Since the general introduction of reinforced concrete it has been sought to derive accurate methods for computing the resistance of various members, notably of beams of various design, and for this purpose it has been found necessary to determine the strength and elasticity of the material. Some of the most interesting investigations in this direction have been made in France by M. Considère, and as a result of his experiments he has announced that concrete, properly reinforced by having metallic members imbedded in it, is capable of being submitted to far greater elongations than concrete not reinforced, and that in his tests the concrete was not cracked and that test pieces of plain concrete taken from the beams after extraordinary elongation showed no material reduction either in crushing or tensile resistance over pieces which had not been subjected to the stretching test. These conclusions, while adopted by some engineers, have not been generally accepted, and subsequent experiments by other investigators have been cited to controvert the position taken by M. Considère. As the subject is an important one in connection with a rapidly growing department of structural work, M. Considère has undertaken a new series of experiments to sustain his position, and in a paper contributed to a recent issue of *Comptes Rendus*, and presented before the French Academy, he gives an account of these investigations.

In his own words, the position which M. Considère has hitherto held, as a result of his experiments, is thus stated:

When pieces of reinforced concrete are subjected to direct tension or to flexure, the fibres under tension behave in the same manner as if they were not reinforced, so long as the tension and the elongation do not exceed those which non-reinforced concrete can support without rupture. If the test is continued still further, reinforced concrete, properly prepared, can sustain much greater elongations, during which the tension remains sensibly constant, and, consequently, its modulus of elasticity is zero.

The fact that this position has been adversely criticised by both German and American engineers has led M. Considère to have a new series of experiments conducted, and in order to eliminate the personal element from these new investigations they were caused to be conducted under the direction of MM. Mesnager and Mercier, in the laboratory of the Ecole des Ponts et Chaussées.

The tests were made upon beams 15 cm. wide and 20 cm. deep, and 3 metres long, these being made by M. Grouselle, a manufacturer of reinforced concrete structures, according to his usual method, without any special precautions. The concrete was composed of 400 kilogrammes of Portland cement, marked E. Candlot & Cie, to 400 litres of sand and 800 litres of calcareous gravel. The quantity of water used represented 9.6 per cent. of the weight of the dry materials.

The reinforcement consisted of two rods of mild steel of 16 mm. diameter, and three rods of 12 mm. diameter, placed close to the side subjected to the greatest extension. One of these beams was protected from the air by being covered with bagging and boards, which were wetted by a hose continuously during the first month, and regularly every two days afterwards, while the other was immersed in water after one day for setting, and kept under water thereafter.

These beams, which were made on May 27, 28, 1904, were subjected to bending tests on November 21 and December 22 following. The tests were made by supporting the beam at points 5 cm. from the ends and applying hydraulic pressure at two points 7 cm. apart at the middle, in such a manner as to give a constant bending moment without shearing action. The extension on the face subjected to tension was observed by two microscopes placed 1.02 metres apart, while the compression on the upper face was measured by two appliances of the Manet-Rabut type, placed 0.5 metre apart.

In accordance with the pre-arranged plan, the test of the first beam was stopped when the extreme elongation of the fibres of the concrete was 0.625 mm., and for the second beam with an elongation of 1.3 mm. In neither case could any fissure be perceived by the microscopes upon examination of the smooth surface of neat cement, which had been applied to the face of the beams under tension in order to facilitate the examination.

Afer the tests the lower portion of the beams, including the steel reinforcement, was carefully removed, and the part immediately above cut by a saw and subjected to separate test. These portions, it must be observed, had been subjected to elongations ranging from 0.22 to 0.55 mm. for the first beam, and 0.56 to 1.07 mm. for the second, while it is well known that non-reinforced concrete breaks before its elongation reaches from 0.10 to 0.20 mm. Now, if these portions, cut out from between the reinforcement and the part of the beam which had not been subjected to the same strain, had possessed only the same elastic limit as non-reinforced concrete, they should have been expected to fall to pieces as soon as they were deprived of support. On the contrary, they showed no traces of cracks or weakening, and in the testing machine these pieces gave excellent results.

These experiments, therefore, have demonstrated that properly prepared members of reinforced concrete can be subjected without injury to elongations far greater than those which would cause rupture in non-reinforced pieces, and that after such extensions the concrete possesses a tensile strength practically equal to that which it previously possessed.

M. Considère admits that members of reinforced concrete frequently show fine cracks and fissures, but he explains these in an entirely different manner than has been used by his critics. When concrete is exposed to dry air after mixing, it experiences a marked contraction during the first few days, when its resistance is yet low. If this contraction is impeded by the metallic reinforcement, the strength of the concrete is not sufficient to compress the metal along with it, and at this period there are formed very fine fissures which subsequently become enlarged when the member is subjected to mechanical tension. If, however, the concrete is kept constantly wet for a sufficient length of time, this contraction does not occur, and there is no tendency to produce fissures before the material has acquired the strength and elasticity to prevent them. There is no doubt that the concrete tends to contract when it is no longer kept moist, but the strength is then quite sufficient, notwithstanding the opposition of the metallic reinforcement, and the cracking does not take place.

It is undoubtedly desirable to provide sufficient cross section to the reinforcing metal to meet the entire tensile stress, but nevertheless it is important to understand the laws which control the deformations of the material. If these are not known, it is impossible to determine the deformations of the entire structure, or the distribution of stresses which follows, neither can the position of the neutral axis be determined in members subjected to flexure, nor the pressures produced in the fibres under compression.

PRINCIPLES OF BLAST-FURNACE PRACTICE.

A REVIEW OF THE FUNDAMENTAL PRINCIPLES INVOLVED IN THE MANUFACTURE OF IRON FROM THE ORE IN THE BLAST FURNACE.

Edward A. Uehling—Franklin Institute.

THERE is probably no one industry of more importance to the engineering world than the manufacture of iron, and yet it is one which has grown up through generations of empirical practice to which the application of scientific methods has only recently been made. In a paper recently presented before the mining and metallurgical section of the Franklin Institute, Mr. Edward A. Uehling, himself identified with important improvements in blast furnace practice, examines the fundamental principles involved in the making of iron in the blast furnace, and shows how the correct use of scientific methods affects the commercial and practical results.

Discussing first the raw materials Mr. Uehling shows the desirability of maintaining uniformity in the ore, this being always possible by making a mixture of various ores in proper proportions. Neither a very lean nor a very rich one is desirable, and a regular mixture of low-grade ores is to be preferred to an irregular mixture of much higher average grade. The chemical elements must be selected with a view of producing the required iron, but the physical conditions are less controllable. Refractory ores should be finer than those which are more easily reducible, but it will not do to have the ore too fine, or too great a resistance will be offered to the blast and too much dust carried over into the flues.

Mr. Uehling discusses the flux, the slag, and the fuel at length, showing the importance of producing a proper slag, in order that the sulphur may be absorbed and the silicon content regulated. Coke is at present used almost entirely as fuel, and its composition should be carefully considered as having an important influence upon the product. Sulphur is objectionable, while the ash should be low in alumina and high in silicon, since most of the silicon in the iron comes from the ash of the coke.

In considering the important element of the blast itself, Mr. Uehling calls attention to the fact that the air is the largest, cheapest, and most neglected constituent of the raw materials involved in the process of smelting. Here the question of uniformity is again most important, although this fact has not been fully realized until recently. The quantity should be regular, the blast being so controlled as to supply a constant volume, as can readily be done by maintaining proper speed of the blowing engines taking into account the barometric pressure and the relative humidity of the external atmosphere from which the supply is drawn. The hot-blast system enables the temperature of the air supplied to be controlled, and although opinions differ as to the actual temperature which it is desirable should be maintained, there is practically no difference of opinion as to the importance of having a controllable regular temperature.

The much discussed question of the drying of the blast is very fully examined by Mr. Uehling; and his own investigations of the subject are especially interesting in view of what has since been accomplished by Mr. Gayley.

"There are few, if any, furnace managers that are not aware of the fact that humidity is an important element in the blast. Very few, however, have taken the pains and the trouble to determine what this factor amounts to quantitatively. During the period referred to above, the author made hygrometric determinations and was surprised to find that the quantity of water carried into the furnace by the blast during the humid summer months amounted to tons of water in twenty-four hours. It is not uncommon for the air to contain 8 grains of moisture per cubic foot. At this degree of humidity a blast furnace taking 35,000 cubic feet of air a minute will, therefore, receive 35,000 × 8 ÷ 7,000 = 40 pounds of water vapor per minute, or 2,400 pounds per hour, or over 28 net tons in twenty-four hours. Since that time (1886) the author has persistently advocated the economical importance of removing this moisture from the blast, and the process of refrigeration as the best method for removing it.

"Knowing the amount of moisture going into the furnace with the blast, it is easy to figure the fuel required to neutralize its chilling effect. Making this calculation we find that one pound of moisture requires in round numbers 1.3 pounds of carbon to be burned at the tuyeres to replace the heat absorbed by the decomposition of the water vapor. This, in itself, amounts to a very considerable quantity of fuel during the summer months, yet it is less than 25 per cent. of the actual fuel saved, as demonstrated at the Isabella Furnaces by Mr. Gayley's desiccating plant.

"The strictest attention is paid by every furnace manager to guard against water getting into the furnace through leaky tuyeres or cooling plates, yet absolutely no regard is given to the contamination of the blast by avoidable moisture. Innumerable steam leaks are often allowed to exist in the engine-room, nearly all of the steam from which is carried into the furnace without any idea of the fuel necessary to overcome this extra moisture. So long as these leaks do not become positively annoying to the engineer, they are rarely attended to. One instance in the writer's experience may be permissible to illustrate. At the plant in mind the blowing engines and pumps were in charge of the master mechanic of the works, over which the furnace manager had no authority. Repeated requests to repair the leaky joints were ignored. Hygrometric tests of the blast showed that it contained between 5 to 7 grains of moisture per cubic foot above the outside atmosphere. Calculations based on this moisture content laid before the general manager brought the necessary pressure upon the master mechanic. The steam pipes were overhauled. The effect was an immediate reduction in the fuel consumption of 150 to 200 pounds per ton of iron. There is no doubt in the author's mind that similar fuel economies might be obtained at many of the existing plants.

"In the author's estimation desiccation of the blast is a step in advance, second in importance only to the hot blast, and that it will be as generally and perhaps even more promptly adopted."

Although the reduction of iron from the ore is essentially a chemical operation, very little is definitely known about the chemical reactions which take place in the blast furnace. We know the nature and composition of the raw material charge at the top, and we can ascertain the character and properties of the product tapped out at the bottom, as well as the composition of the escaping gases. These are indications of what is actually going on inside of the furnace, but only indications. Mr. Uehling discusses the reducing action of the carbon monoxide produced by the burning of the carbon, and also the phenomenon of carbon impregnation, with its consequences of hanging of stock; slippingg, both top and bottom; and scaffolding; and holds that many of these operative disturbances may be greatly reduced if not entirely eliminated by careful preparation and charging, uniform blowing, desiccation, and regular heating of the blast.

The important question of the utilization of furnace gases is given especial consideration by Mr. Uehling, and he refers to his own early computations upon the blast furnace as a power plant, in which he showed that, under conditions of best average fuel consumption, viz., 2,000 pounds of coke per ton of iron, and proper treatment and utilization of the gas, there would be a surplus of at least 800 horse-power per ton of iron produced per hour. Or, in other words, a blast furnace of a daily capacity of 250 tons, or, in round numbers, 10 tons per hour, should have a surplus of gas over and above all furnace requirements, sufficient to generate 8,000 horse-power in any of the available types of large gas engines. Other investigators, notably Mr. B. H. Thwaite, who is the pioneer in the field of direct utilization of blast-furnace gas, have come to similar conclusions.

"Since publishing the above calculations, the author has had opportunity to investigate the blast-furnace gases at a number of the large iron and steel plants, and has found that his figures were very conservative; that from 1,000 to 1,200 horse-power is nearer the actual surplus power that should be available.

"In view of these facts, and the practically more weighty fact, that on the continent of Europe, especially in Germany, there is scarcely a furnace plant where not from several to many thousand horse-power are generated by blast-furnace gas direct, is it not strange that, with one laudable exception, nothing at all has been done to save the enormous waste now going on because of the irrational application of the blast-furnace gas?

"From 45 per cent. to 50 per cent. of the heat value of the fuel used in the process of smelting in the blast furnace is contained in the escaping gases, of which 35 per cent. should be sufficient to heat the blast and produce the power to run the furnace and all its mechanical accessories. In spite of this enormous theoretically demonstrable surplus heat energy, the fact remains that, at the majority of the blast-furnace plants, hundreds of tons of coal are burned annually to assist the gas in generating the necessary steam for the power required, and it is the exception rather than the rule that the desired blast temperature can be regularly obtained from the stoves, notwithstanding the fact that both stoves and boilers have from time to time been increased both in size and number. The sole reason of this deplorable condition is due to the fact that the uncleaned gas cannot be efficiently utilized. It is just as irrational to burn the impure gas as it would be to attempt to burn coal mixed with all the slate and rock that is dug and raised with it from the mine."

RAILWAY REPAIR-SHOP MANAGEMENT.

THE ADVANTAGES OF OPERATING RAILROAD REPAIR SHOPS ON THE MONTHLY APPROPRIATION PLAN.

Charles Streicher—New York Railroad Club.

AMONG the various systems of works management which have been advocated by the able engineers and superintendents who have given attention to the subject but few have considered the subject of the repair shop. In nearly every case the existing systems have been planned for the manufacturer, and when the special shop is considered it is generally attempted to modify some of the plans for what may be termed shops of original production, to fit, as nearly as may be, the special case under consideration.

Nearly all railroads now purchase their locomotives and other rolling stock, but practically all roads maintain repair shops, not because of any idea that they can do the work more economically than others, but because it is absolutely essential to have control of the work and to be able to handle emergency jobs in accordance with their own knowledge of the requirements. At the same time it is altogether possible to conduct such repair work so that it shall be done at minimum cost as well as in minimum time, and hence any discussion of the methods of management of such shops is of importance and interest. In a paper recently presented before the New York Railroad Club Mr. Charles Streicher discusses the cost of making repairs on rolling stock, and shows that the absence of proper system may lead to unnecessarily high average charges per locomotive and car.

In order to reduce these repair charges, Mr. Streicher advocates the introduction of the monthly appropriation plan, and maintains that by this method millions can be saved and the equipment at the same time. By the monthly appropriation plan is meant the practice of appropriating a fixed amount of money each month for each division for the purpose of paying for the maintenance of equipment, labor and material in the shops, yards, inspection, points with the clear understanding that pay rolls and purchases of material must not exceed the amounts appropriated, except in cases of unavoidable emergencies, and then only by furnishing satisfactory explanation.

"This method differs from the more general practice of running up unlimited pay rolls and for purchase of material not needed for immediate consumption by putting a positive and reasonable prohibitive stop to it.

"This method, instead of having the general officers guessing what the monthly expenditures and demand on the treasury will be, enables them to make positive financial arrangements.

"This method, instead of opening up wide avenues for extravagance, also expenditures not immediately necessary, making the fellow who spends the most think he is doing the most work, is a direct mandate, and also appeals to all concerned, for economy, offering those alive to the opportunities the chance to produce 'maximum results with minimum cost.'

"This method, instead of throttling individuality, develops inventive, executive and managing ability, educates men and cultivates the habit of making the most of adverse-looking circumstances and opportunities, if not hampered by red tape.

"To formulate a plan, system or method, and to introduce and execute same successfully are two vastly different propositions.

"The introduction of the method is generally disliked. All kinds of adverse criticism and predictions are made. If, however, theh executive officers, general foremen and foremen are of the right kind, practical men. capable of taking the wheel in their own hand, willing and able to demonstrate with tact, firmness and personal efforts the feasibility, in short, are competent to educate the men up to the method and gain thereby their co-operation, all is well. The successful execution depends largely on appropriations, based on recorded facts, coupled with reasonable expectations. They must be made with due consideration of shop facilities, locality and circumstances, rarely found alike on different divisions."

As a base for determining the appropriations it is necessary to have the cost statements, including labor and material, covering different classes of engines and cars, summarized and averaged as to parts and units of equipment. These statements must then be distributed in parts to all officials in their respective departments, down to the position of assistant foremen, gang bosses, inspectors, including shop accountants and time clerks, receiving fixed daily or monthly compensations. There must then be made a monthly distribution of comparative average cost sheets, per unit of equipment, covering the entire system. The division officials should make out monthly reports, expressing their experience under the method, backed up by figures and facts, with practical propositions as to how equipment expenses may be reduced and material saved, these to include suggestions as to the possible limitations of the amounts to be appropriated, taking into account the working conditions to be met.

Mr. Streicher considers it absolutely necessary, for the successful execution of the scheme, that the locomotive and car shops should be operated under the piece-work system, both for skilled and unskilled labor. As he says: "It is simply ridiculous to assume that after contracting for locomotives, cars, and implements for so much apiece, and the purchase of material by measurable quantities in pounds, tons, feet, gallons, etc., that we should permit the practice of maintaining and repairing the same things by the unmeasurable, bottomless, go-as-you-please day methods."

The appropriations of each division

should be made by the general executive officers in lump sums, in consultation with the superintendent of motive power. It is a mistake, possibly fatal in consequences, to bind division master mechanics and master car builders down to itemized appropriations, since thereby the personal responsibility of division officers is logically removed from them. In view of the nature of the offices they hold and the duties connected therewith, general executive officers cannot be familiar with the actual detail condition of the motive power and rolling equipment of the entire system. This absolutely essential personal knowledge of existing conditions can only be had by the man on the spot, and therein his resources lie. If he is given a reasonable appropriation and material allowance he may well be expected to conduct the work according to conditions, following the rule of give and take, and using his appropriation, within his limitations, according to circumstances.

The limitations of the appropriation system will soon be reached by those railroad officials who introduce the method with the sole desire of making a personal record, regardless of the conditions of the equipment; but if, on the other hand, their guiding motive is to obtain the best service for the least money they will continually find new ways of accomplishing their purpose.

If success is to be attained care must be taken to avoid certain causes of failure which Mr. Streicher enumerates. Thus it is a mistake to attempt to drive the employees, instead of persuading them to aid in the work. Again, if at first appropriations are exceeded, the matter must be examined impartially, to give the parties responsible a chance to redeem themselves, after the source of the trouble has been discovered, since all success must come from the individual efforts of the men who are ultimately responsible. It is a mistake to cut the appropriations too low, or to hamper division mechanics and master car builders with interference; rather they should be given full swing coupled with corresponding responsibility as regards results.

"Within the last ten years we have witnessed the construction of the most powerful locomotives, doing the work of two or three of the older types. Steel cars and cars with steel underframes, having carrying capacity from 80,000 to 100,000 pounds, are replacing wooden equipment. On their construction is based the expectation of reducing cost of repairs at least 25 per cent. Modern shops, with all conceivable facilities to handle material economically, have been built. Lathes, planers, boring mills, drill presses, punches, morticers, gainers, etc., are in operation, capable of handling double the previous output. Self-hardening tool steel has shattered all cutting records, lineal as well as diametrical. Pneumatic, electric, hydrostatic machinery and tools unknown ten years ago are common now.

"Consolidation of small roads, with larger systems, is the order of the day, on which the hopes of reducing maintenance of equipment expenses are based."

With all the efforts which have been made to centralize administration and to detail and systematize the work, the proportion of maintenance and equipment expense to total operating expense has from 1897 down to 1903 increased from 16.352 per cent. to 19.133 per cent., while during the same period conducting transportation has been reduced from 57.92 to 55.89 per cent., and general expense has been lowered from 4.756 to 3.789 per cent. This is attributed by Mr. Streicher to the fact that the individuality of the men who are responsible has been neglected, and it is to stimulate and develop this individual factor that he recommends the introduction of the monthly appropriation system.

While the argument of Mr. Streicher is excellent, it is possible that there is another reason why the repair account has increased while other departments have lowered their expenses, namely, the present tendency to drive the equipment to the fullest possible capacity, regardless of wear and tear, on the theory that an appliance should be worn out in service before sufficient time has elapsed for it to become obsolete. The ultimate economy of this principle is well established, and it is entirely reasonable that it should be accompanied with an increase in the proportional repair account along with a decrease in the other departments whose performance it may have helped to improve.

THE DEVELOPMENT OF THE LARGE GAS ENGINE.

PROGRESS IN THE DESIGN AND CONSTRUCTION OF POWERFUL INTERNAL-COMBUSTION ENGINES IN GERMANY.

Prof. E. Meyer—Stahl und Eisen.

THERE has been no more interesting feature in mechanical engineering in recent years than the increase in magnitude and power of the internal-combustion motor. Writing in the pages of this Magazine in 1898, Mr. Dugald Clerk, one of the pioneers in this important field, discussed the large gas engine from the viewpoint of that date, and made the prediction that in the future "there will be gas engines as powerful as any steam engine ever built." At that time the largest gas engine in existence was of 200 horse power, and this consisted really of two 100 horse-power engines coupled, and in view of this enormous machine, Mr. Clerk refers back with amusement to the fact that in 1879 a 16 horse-power Crossley engine was admired as the "King of Gas Engines," being the greatest in existence then and for several years after. Mr. Clerk also made an interesting prediction, which has been more than verified, namely: "It is evident that the large engines of ten years hence will differ as much from the large gas engine of to-day (1898) as does the latter from the engine of 1886 or 1887. There can be little doubt that in ten years, gas engines of 1,000 h.p. will be as common as engines of 100 h.p. are now."

At the meeting of the Verein Deutscher Eisenhüttenleute held recently in Düsseldorf, a paper on large gas engines was presented by Dr. Eugen Meyer, and published in recent issues of *Stahl und Eisen*, describing some of the recent developments in large gas-engine construction on the Continent. and it is seen that the prediction of Mr Clerk has been fulfilled in a much shorter period than the ten years which he named. In his paper Dr. Meyer illustrates and describes engines of 1,000 to 2,000 horse power, representing such establishments as Oechelhäuser, Otto, Körting, Krupp, Cockerill, and others, the limit in size set by Mr. Clerk being exceeded as much as the time has been shortened.

The increase in the power of gas engines has been brought about by several circumstances. The early machines were intended to be operated by illuminating gas, and the cost of this fuel naturally limited the use of such motors to small powers, where convenience and operative conditions were of greater importance than the actual cost of the power. The thermal efficiency of these small motors was much higher than that of steam engines, but the cost of the fuel overbalanced the heat economy. With the introduction of producer gas, and especially since the utilization of the waste gases of the blast furnace has been developed, the question of the supply of low cost fuel has been solved, and there are no limits to the size of units except those imposed by constructive questions.

The earlier large engines were built upon the four-cycle system, and of this class was the large Cockerill engine which attracted so much attention at the Paris exposition of 1900. Messrs. Körting increased the power of their machines at first by employing two opposing four-cycle cylinders, but this plan was later followed by the use of two tandem cylinders, this being important as demonstrating the practicability of using packed stuffing boxes in gas engine construction. With this arrangement came also the use of water-cooled pistons, both rod and piston being included in the water circulation.

In examining the leading types of large gas engines, Professor Meyer takes up first the Oechelhäuser engine, and then considers the two-cycle machine of Körting, giving also some examples of the double-acting tandem four-cycle engine. The Oechelhaüser engine, as is well known, has two opposing pistons in a single cylinder, these being connected to the same crank shaft so as to approach and separate every revolution. A pump is used to give the charge a preliminary compression as well as to supply a scavenging discharge of air, the two pistons covering and uncovering the ports in the cylinder at the proper times, the charge being ignited electrically. Engines of this type have been built with a single cylinder up to 1,500 horse power, many large Oechelhaüser engines being in use in German iron works for supplying the blast to the furnaces, using the waste gases from the blast furnaces as fuel.

The Körting two-cycle machine is designed on the general lines of a horizontal steam engine, with closed cylinder, stuffing boxes, and power strokes on each side of the piston. The two-cycle action is secured by the addition of a separate compression pump, this pump having mechanically-operated valves, similar to the Rider expansion valve for steam engines, the governor controlling the gas charge by regulating the admission to the pump cylinder.

The various attempts to make a successful two-cycle gas engine have resulted simply in making some substitute for the suction and compression stroke in the Beau-de-Rochas cycle, so that it has been generally found simpler in practice to couple two four-cycle cylinders rather than to attempt to make a two-cycle machine. The latest designs of large gas engines have been made with two four-cycle cylinders arranged in tandem, and in some instances these have had double-acting cylinders, involving closed cylinders, stuffing-boxes, and water-cooled pistons and rods. Engines of this type as large as 2,000 horse power have been built by the Deutz works, with cylinders of 1,100 mm. bore and 1,300 mm. stroke (43.3 in. by 51.2 in.) and similar machines have been built by other well-known makers.

The design of such large gas engines involves something more than the mere enlargement of details of smaller machines. Noteworthy in all of the examples illustrated by Professor Meyer are the arrangements for cooling, not only the cylinders and pistons being water-cooled, but the mushroom valves themselves, being sufficiently large, are also fitted with water circulation, as are also the chambers in which they are fitted. The general arrangement of the water circulation is a matter to which especial attention should be given, the cold water being first directed about the actual explosion chamber, where the greatest amount of heat is generated and from which it must be quickly absorbed, after which the water is passed to those portions less exposed to the highest temperature.

Professor Meyer calls attention to the importance of providing rounded corners and fillets in the interior portions of these large cylinders, especially at the points where the ports enter, since cracks are apt to form at such points under the great temperature variations if sharp angles and corners are left. The working parts should also be so arranged as to permit free expansion and contraction, and in general, the precautions which have repeatedly been urged as necessary for steam engines operating with highly superheated steam, demand even greater attention in the case of the large gas engine.

The performance of these large gas engines may be gathered from some figures which are given by Professor Meyer. Thus a 500 h. p. Oechelhäuser engine, using coke-oven gas and driving a blowing cylinder, required 1,930 calories per indicated horse-power-hour, including the power required to drive the air pump, and taking the metric horse-power-hour as equal to 632.5 calories, this gives a thermal efficiency of 32.7 per cent. on the indicated power. Allowing for the frictional and other resistances, the heat consumption is given as 2,340 calories per brake horse power, corresponding to an efficiency of about 27 per cent. Similar data for a Nürnberg engine of 1,200 h.p., using blast-furnace gas, showed a heat consumption of 2,260 calories per brake horse-power-hour, or a thermal efficiency of 28 per cent. In general the four-cycle engine is somewhat more efficient than the two cycle, since the negative work in the first case is only about 6 per cent. of the indicated power, while the use of a separate air pump raises the negative work for the two cycle machine to between 10 and 11 per cent., with a corresponding decrease in efficiency.

The prediction made by Mr. Clerk in 1898 has thus been more than fulfilled, and internal-combustion engines of more than 1,000 horse power are already common and have been repeatedly exceeded. With the increasing use of gases from blast furnaces and from coke ovens together with the improvements in gas producers which shall enable them to use freely the lowest grades of fuel, the employment of the vapor of water as an intermediary agent in the conversion of heat into mechanical energy will be rendered unnecessary, except in a limited number of special cases.

POWER FOR ELECTRIC RAILWAYS.

CONDITIONS GOVERNING THE PROPORTIONS AND ARRANGEMENT OF THE STEAM POWER PLANT FOR ELECTRIC TRACTION OPERATION.

E. P. Roberts—Ohio Interurban Railway Association.

IN making the preliminary plans and estimates for a steam power plant it has usually been sufficient of the designing engineer to know the general character of the work to be done in order to enable him to make the proper arrangements. For a manufacturing establishment such as a textile factory, for instance, he knows that uniformity of speed regulation is most essential, and given the number of spindles, looms, or other machines, he is able to decide definitely the size of engines and volume of steam to be supplied. Again, for a rolling mill the irregular demands for power are well understood, and suitable devices included in the regulating mechanism to enable the attendants to throw on all the power necessary in the instant of emergency.

With the introduction of electric power for urban and interurban traction, however, a new set of operative conditions were introduced, and it has required all the observation and experience of able and practical engineers to determine the best methods of arranging the plant to meet the requirements. In a paper recently presented before the Ohio Interurban Railway Association by Mr. E. P. Roberts the question of steam power for electric railroads is very fully discussed, and some abstract of the paper is here given.

"To decide what prime mover is best for a specific case, considering type, number of units and size of each, all the factors affecting the case must be considered, and, generally speaking, in the following order:

"First—Predetermination of the operating conditions.

"Second—Estimate of first cost.

"Third—Estimate of operating expenses, including financial charges.

"Fourth—Comparative reliability, depreciation and repair account, and other matters which are largely questions of judgment.

"Fifth—Combination of all the above, considered for each type of power plant, and a comparison of the results.

"This necessitates a decision as to the location of the track, and the curves and grades most economically desirable, and the predetermination includes the following:

"A certain location of the road is taken as the standard for comparison, being generally that which will give excellent, though not necessarily the greatest, accessibility on the part of the public, and having such grades and curves as a general knowledge of the proposition indicates would be good practice. The size of cars and number of trains necessary to handle the anticipated passenger travel is decided, and train schedules and train sheets are prepared which show the schedule time between the terminal points, based on a stated average schedule speed in the cities and towns, and a stated average speed while the car is in motion in the country, with deduction from the latter on account of country shops, thereby obtaining the schedule speed in the country. The train sheet shows the trains in service at any moment and the location of such trains. The size of motors necessary to handle a car or train of the assured weight and speed is then calculated."

The importance of thus making a preliminary layout of the whole system appears in the fact that a study of such a scheme often shows where useful modifications may be made, while there is yet time. Mr. Roberts gives several examples to show the difference in the cost of operating roads which have been carefully planned and those which have not had the same consideration, indicating very clearly the money value of careful and competent preliminary work.

"Having predetermined the average maximum power required from the engine, or engines, when operating on regular schedule, and also for special days, a tentative decision is made as to the number of units and the size of each, based on capacity.

"The condition of operation of engines furnishing power to an interurban electric road is, except when storage batteries are used, one of rapid and excessive fluctuations of load, usually ranging from 25 per cent. to 125 per cent. of the rated capacity of the engine, and often from 0 per cent. to 150 per cent., and sometimes momentarily up to 200 per cent.

"For any engine supplied with steam at a definite pressure and quality and with a definite vacuum, there is a definite load at which it will operate at its greatest economy. Increasing the steam pressure, or superheating the steam, or increasing the vacuum will increase the maximum obtainable horse-power and, generally speaking and within limitations, the efficiency of the engine as a converter of heat energy into mechanical energy, but, considering the increased energy required by the engine auxiliaries, it will not necessarily increase the heat-energy efficiency, considered as a whole, and, even more important, it may even decrease the 'dollar efficiency.' The latter efficiency includes first cost and operating expense, and it is upon this efficiency, considering the entire road, that either dividends or assessments are declared."

By studying curves obtained from the operation of existing plants, some useful lessons may be drawn for comparison in planning new works. Thus it is made evident that a comparison of engine performance based upon the water consumption of the respective engines when operating at their rated capacity, it not reliable for a decision when the engines are to be operated under variable loads.

In like manner comparisons based on indicated horse power do not give the same results as those based on boiler horse power. Engines for interurban electric railways are obliged to operate with loads varying from the mere friction load to 100 per cent. overload, but the average load is practically always below the normal rating. The engine should therefore be designed so as to carry excess loads with safety, and also to give a maximum steam economy at a point below that which is ordinarily considered normal rating. The valve gear should permit the steam to follow a large percentage of the stroke when necessary, and the pipes and connections arranged so as to produce the minimum drop in steam pressure, while the cylinder should be no larger than absolutely necessary.

It is very desirable that fuller information should be available concerning the performance of steam engines at various loads. Nearly all builders have reliable data from numerous tests as to the performances of their engines at normal rating, but the results at fractional loads, often more important in their effects upon the economy of the plant, are not so easily obtainable. A comparison of several engines at various proportional loads brings this out very clearly, and the point is one to which engine builders may well give interested and practical attention. Instead of limiting themselves to reports of tests showing the excellent performances of their engines at normal power, they would find a distinct commercial advantage in publishing reports of reliable and disinterested tests of these same machines at several loads above and below the normal, showing the range of variation which the customer who has a variable load to meet might expect.

Mr. Roberts has some interesting remarks to make about the comparative performances of steam turbines and reciprocating engines, and he believes that the better results reported where turbines have been installed are due to the fact that the turbine plants have been of a higher grade than the engine plants with which they have been compared.

"Turbine plants generally have superheated steam. frequently at a higher pressure than the average reciprocating engine, and also with higher vacuum, and they do obtain better efficiency from the standpoint of water per kilowatt-hour than the majority of the engine plants in interurban power houses. But it does not necessarily follow that reciprocating engine plants could not have been so designed as to have obtained equally high efficiency, nor does it follow that the plant which is most efficient from the standpoint of fuel is the most economical, everything considered. I believe in the steam turbine, but do not consider that it has the field to itself. but rather that each case must be considered on its own merits.

"Many comparisons which have been published are misleading. For example: Some comparisons are made on the basis of rated load, which have been shown to be inaccurate when applied to a variable load; others are based on pounds of steam per kilowatt-hour taken by the turbine or the engine, and without making allowance for the additional heat energy required to obtain the higher vacuum for the turbine. In this connection it should be noted that the efficiency of the turbine is materially increased by an increased vacuum, whereas this is much less the case for an engine built on commercial lines. For the turbine it is wise to obtain high vacuum, but the cost must not be overlooked.

"The steam for the turbine is also usually superheated, and, if the comparison is based on a difference in pounds of steam, it is evident that consideration should be given to the additional heat units in the steam and the cost of supplying such additional heat energy. When considering fuel economy the proper basis of comparison is the per cent. of heat energy transformed into mechanical energy delivered by the mechanism, including the amount of energy required for the auxiliaries."

Mr. Roberts's paper is a valuable contribution to power-plant engineering, and adds one more to the many evidences that the engineer is becoming more and more of a business man, according to the definition that an engineer is a man who can do for one dollar what any fool can do for two dollars.

EXPLOSIONS IN AIR COMPRESSORS.

CAUSES OF IGNITIONS AND EXPLOSIONS IN THE DISCHARGE PIPES AND RECEIVERS OF AIR COMPRESSORS.

Alex. M. Gow—Engineering News.

THE subject of explosions in connection with the use of compressed air has, until recently, received much more attention in Europe than in America, and in fact, after a discussion and review in these columns of some explosions which occurred in Germany a few years ago, the very fact that such accidents could take place was vigorously contested by an able engineer, experienced in compressed-air machinery. We now have a very full discussion of experiences in America with explosions of this sort, and from a paper by Alex. M. Gow in a recent issue of *Engineering News* we abstract some important points.

"Ignitions and explosions in the discharge pipes and receivers of air compressors are by no means uncommon. The increasing use of compressed air at higher and higher pressures, together with the general ignorance on the part of the men in charge of the machines, as to how and why such accidents occur, make it probable that they will continue to occur with greater frequency. For very obvious reasons the manufacturers say as little as possible about the subject to prospective buyers. It cannot be expected that the men in charge at the time of accident will make any report that will reflect upon themselves. So it happens that in but comparatively few cases of these accidents have the results of careful investigation been given to the public at large.

"From an examination of about twenty accidents, of which more or less complete data have been gathered, a clear conception of the causes has been formed, from which may be drawn definite conclusions as to the means of prevention. In a number of the cases examined serious explosions have occurred, resulting in fire and death; in others, simply ignition, or burning out, with no other damage than that to pipe joints and gaskets. One case of a Bessemer blowing engine is reported where the pipes have been red hot on several occasions and been allowed to burn out. In another case the ignition so vitiated the air that was being sent into a mine that men were asphyxiated. The report upon a very serious explosion states that 'the air in the discharge pipe first caught fire and then exploded,' it having been observed before the explosion that the pipe was red hot.

"These accidents are not confined to any one type of compressor, nor are they confined to cases where the terminal gage pressure is unusually high. It is in the discharge pipe and receiver that the trouble occurs, and in most cases the compressor escapes without injury. Rarely, if ever, does the explosion take place immediately in the cylinder. One case is reported where the cylinder head was blown off, killing the man who was examining the discharge valves, but even in this case the evidence does not prove that the explosion did not originate in the receiver.

"It is perfectly evident that just before such an accident there must be something to burn, in the discharge pipe or receiver, and a temperature sufficiently high to ignite it. Accumulation of combustible matter, together with a terminal temperature at the end of a compression stroke sufficient to start combustion, accounts for the cases of ignition; the presence of a gas or vapor, forming an explosive mixture with the air, with a temperature equal to the burning point of the vapor at the pressure, accounts for the cases of explosion. Where, as is reported in a few cases, ignition has preceded explosion, it is clear that in the first place there was a sufficient temperature to start combustion, and then there was driven off a gas or vapor, and this, mingling with the air in suitable proportions, formed an explosive mixture. We have, then, to inquire as to the origin and nature of the combustible matter and to the causes and conditions that tend to produce excessively high temperature."

The combustible matter, consisting of various accumulations of hydrocarbons, is derived from the lubricants necessarily used in the compressing machinery, while in and around all collieries this is mixed with coal dust drawn in with the air. The lubricant is the principal source of the trouble, however, and hence the first precautions are to be taken as to its character and the quantity used.

The lubricants generally employed are a mixture of soap and water or cylinder oil. Either will produce a carbonaceous deposit, particularly when used in such excess as to permit a quantity to be carried over from the compressor cylinders into the receiver and pipes. Deposits formed from soap and water have been found to ignite at temperatures between 400° and 500°. The greatest trouble, however, is found with explosions, rather than mere ignitions, and these require the formation of a combustible vapor and its mixture with a suitable proportion of air. Since it requires but a low percentage of hydrocarbon vapors to explode in air, and as this percentage diminishes with the temperature, while the explosiveness increases with the pressure, it will be seen that the elements of danger are present in very many cases.

"Now, combustible gases or vapors are evolved from all lubricating oils by heat. The lowest temperature at which they begin to come off is called the 'flash point' of that oil. At a somewhat higher temperature the gas or vapor will ignite; this is called the 'burning point.' The flash point of kerosene is usually below 150° F. Ordinary lubricating oils flash at about 250° F. An average of determinations on 40 samples of heavy oils having average flash point of 360° F. gave average burning point of 398° F.; high flash test cylinder oils, from 500° F. to 560° F., gave burning points of 600° to 630° F. The vapors evolved from any of these oils, at the flash point, or the oils themselves, atomized or sprayed, would form an explosive mixture with the suitable percentage of air. From the above table it is evident that as low as 1 per cent. by volume would form such a mixture. If the oil were mixed with coal dust the temperature at which such a deposit would evolve a vapor would be the flash point of the oil. It follows that none but high flash test oil should be used in the cylinder."

In order that the danger from explosions may be minimized care should be taken both in the design of the apparatus and in its use. The discharge valves and clearance spaces should be so arranged that there may be no small pockets or recesses where oil may accumulate. Even with the greatest care in design and in the most sparing use of lubricant there will be some accumulation of carbonaceous matter while the danger from coal dust drawn in with the air is always present.

So far as the temperatures produced in the compressors are concerned, these depend upon the degree of compression for their origin. The temperatures attained, however, are very materially affected by two elements, one being the temperature at which the air is originally drawn in and the other the effectiveness of the means which are provided for carrying off the heat and preventing its accumulation. Mr.

Gow gives a diagram with curves showing the rise of temperature due to the adiabatic compression of dry air and these show very clearly how the rate of increase in temperature depends upon the initial temperature of the air.

The use of water jacketing. for the cylinder walls and heads, is necessary to prevent the working parts from becoming too hot, but Mr. Gow shows that on large machines the water jacketing of the compressor cannot be depended upon to absorb the heat of compression, since there is too much heat produced for the time and surface available.

"Compression by stages, with inter-cooling, with provision for after-cooling in an emergency, are the surest means by which to avoid dangerously high temperatures in the receiver. The curves show the reduction in terminal temperature that may be attained by inter-cooling to any temperature between stages, and inasmuch as for adiabatic compression, the rise of temperature is proportional to work expended, they also show to what pressure each cylinder should operate in order that each shall do an equal amount of work. Knowing the weight of air compressed per stroke and its specific heat, the curves also give the necessary data from which to calculate the British thermal units to be absorbed by the inter-cooler."

The experiences with air compressors are of especial interest in connection with the results which are well-known in connection with internal-combustion motors. Although the cylinders of gas engines are well jacketed with cold water circulation, and in the larger sizes water cooling is used for the pistons, cylinder heads, and even the valves, it is well understood that the compression cannot be carried to the most advantageous extent because of the danger of preliminary ignition and explosion of the mixed charge of gas and air. In the Banki motor the temperature is kept down by spraying water into the charge, and it is held that one of the advantages of alcohol as a fuel for internal-combustion motors is the presence of sufficient water to aid in keeping down the compression temperature. One of the ingenious features of the Diesel motor lies in the utilization of the heat of compression for the ignition of the charge, and by compressing the air separately, and not injecting the oil until the beginning of the power stroke, very high compressions are employed with safety. Although the cylinder of the Diesel motor is water jacketed the temperatures reached in the cylinder are sufficient to ignite and to burn completely the heaviest oils and petroleum residues, and even coal dust has been successfully burned in these motors, the only difficulty with such powdered fuels being the injurious effect of the non-combustible particles of ash, etc., upon the interior of the cylinder.

Mr. Gow's paper is a valuable contribution to the subject of the design and use of air-compressing machinery, and the recommendations and suggestions which he makes, based upon the past and costly experience of many users of compressors, are worthy of careful study and utilization.

ALTERNATING-STRESS TESTS.

METHOD AND APPARATUS AT THE NATIONAL PHYSICAL LABORATORY FOR DETERMINING THE BEHAVIOUR OF MATERIALS UNDER ALTERNATING STRESSES.

Dr. T. E. Stanton—Engineering.

ENGINEERS are gradually beginning to appreciate the fact that there are other data desirable to be known about materials of construction besides the mere tensile strength. At one time the ultimate resistance to tension was about the only thing which was attempted to be ascertained, and this fact has been attributed, rightly or wrongly, to the preponderating influence of the work of Kirkaldy and his followers. Then it appeared that other things were of importance, and now we have apparatus for making torsion tests, shearing tests, crushing tests, and a variety of other experimental determinations of the resisting properties of the materials used in engineering structures. Among these later researches the study of the effects of vibration and of frequently repeated stresses is being given increased attention, and various special testing machines have been designed for this department of mechanical research. The latest apparatus of this kind is the new machine designed and constructed for use at the National Physical Laboratory, and from a very complete account of this important testing machine by Dr. T. E. Stanton, published in a recent issue of *Engineering* we abstract the following account.

"Experiments on the effect of alternating stresses were first made by Wohler, whose experiments were subsequently repeated by Spangenburg in 1874. Sir Benjamin Baker has also published the results of experiments, made in some cases by simple bending, and in others by Wohler's method, which consisted in the rotation of a bar to the end of which a definite bending moment was applied, and which is obviously the simplest and most easy to carry out. More recently a machine has been constructed, and a most valuable series of experiments made by Reynolds and Smith, in which for the first time direct tension and compression uniformly distributed over the section of the specimens was obtained. The method adopted was that of employing a rotating crank to cause periodic motion of a reciprocating mass by means of a connecting-rod, the specimen under test forming the connection between the reciprocating mass and the cross-head; so that an alternating force was produced in it, depending on the magnitude of the mass and the speed of rotation of the crank. The machine consisted essentially of a single-balanced crank, which operated two reciprocating equal masses in the same vertical plane, to one of which was attached the specimen, whose motion was vertical; the other, whose motion was horizontal, being utilised to keep the kinetic energy of the system, and therefore the speed of rotation, constant.

"As experiments on uniformly distributed stress are undoubtedly of far higher value than those on bending, in which the maximum stresses exist at the surface of the specimen only, and their real values are difficult to determine, it was decided to adopt the method of Professor Osborne Reynolds in the design for the National Physical Laboratory machine, with the modification that four cranks operating four specimens should be employed instead of one. By introducing this modification a machine could be made, the moving parts of which would be perfectly balanced, the speed of rotation practically constant, and which would allow of the comparison of four different qualities of material under exactly the same stress conditions throughout the life of the specimens. The importance of this last condition will be readily understood when the difficulties are considered of obtaining an exact comparison between the resistances of various specimens which have been tested separately, involving as they must the greatest care in speed regulation to obtain the same stresses in each trial. The chief objection to this four-cranked arrangement was that it practically entailed the horizontal motion of the masses, but it was hoped that the consequent frictional effects could be made so small as to be negligible. A further advantage lay in the fact that with the four cranks the method of balancing could be made independent of the ratio of the crank-arm to the connecting-rod, so that a length of crank-arm could be adopted which would enable experiments to be made at considerably lower speeds than those obtained by Reynolds and Smith, which were in no case lower than 1,300 per minute, the experiments of Wohler and Sir Benjamin Baker being made at about 60 revolutions per minute. Further, the results of the high-speed trials, ranging from 2,400 to 1,300 alternations per minute, showed that, for a given range of stress, the life of the specimen depended largely upon the period of the alternation, so that it was considered most desirable to extend the observations to speeds which are more commonly obtained in practice."

The machine is illustrated and described in detail by Dr. Stanton, and it presents many elements of interest. There are two independently-balanced systems on the same crank shaft, each system consisting of two cranks placed at 180 degrees with each other, with the connecting rods, cross-heads, and specimens on opposite sides of the crank shaft. The parts are so arranged that the reciprocating masses are exactly equal and the crank shaft is balanced in itself, while the adjustments of the completed machine included the distribution of material in the connecting rods so that the centres of percussion should be similarly situated in the connecting rods. The cranks of the second system are placed at right angles to those of the first, so that the kinetic energy of the reciprocating parts shall be approximately constant, thus keeping the fluctuations of speed during a complete revolution as small as possible. Special care has been taken in the provisions for lubrication, and the frictional resistances have been carefully determined, so that corresponding corrections can be made.

As in other forms of testing machines, the appliances for holding the specimens undergoing test have been designed so that there shall be no preliminary stresses created to affect the value of the results. Since the fracture of any one of the test pieces would destroy the balance and possibly wreck the machine it has been necessary to introduce a clutch which comes into action the instant a specimen is fractured. India rubber buffers, with a very small clearance, are also provided, and the contact made with a buffer at the instant of the fracture of a specimen, serves to give an electric warning and enable the time and counter readings to be made. The machine is driven by an electric motor, speeds from 500 to 2,000 revolutions being attainable, with control for any intermediate speed.

THE TANTALUM LAMP.

AN ACCOUNT OF THE NEW INCANDESCENT LAMP OF THE SIEMENS AND HALSKE MANUFACTURING COMPANY.

W. von Bolton and O. Feuerlein—Elektrotechnische Zeitschrift.

IN the early history of the incandescent lamp various attempts were made to use platinum as the material to be raised to incandescence by the heat of the electric current, but these were abandoned when success was reached with the carbon filament. Of late years, however, experimenters have been busy with other materials among which may be noted the Nernst "glower" and the osmium lamp of Dr. Auer von Welsbach. For some time the well known firm of Siemens and Halske has been conducting experimental researches with lamps using tantalum as the incandescent material, and at a recent meeting of the Electrotechnical Society in Berlin a paper was presented by Dr. W. von Bolton and Dr. O. Feuerlein, the two experts who have been conducting the work in the laboratory of the company, giving an account of the results which have been thus far attained. From a report of this important paper in the *Elektrotechnische Zeitschrift* we abstract some of the principal features of this work, which may lead to important changes in incandescent lighting.

Experiments with vanadium, while proving unsuccessful, pointed to other members of the same chemical group, and trials were made with niobium and tantalum. Niobium, although having a higher melting point than vanadium, failed to stand the action of the current, and experiments were therefore made with tantalum. Here the principal difficulty appears to have been the production of coherent metallic tantalum, free from brittleness and capable of being drawn into wire suitable for lamp filaments. This portion of the work was entrusted to Dr. von Bolton, and is described by him. Experiments upon the reduction of tantalum direct from the oxide were only partially successful, but finally it was discovered that by melting the powder in a vacuum the contained gases separated, and a ductile metal was obtained. With the tantalum wire thus produced Dr. Feuerlein proceeded to construct the lamp.

By using wire about 0.3 mm. in diameter it was demonstrated that the melting point of the metal was very high, and also that even under the action of a heavy current there was but a slight tendency to disintegration. The first lamps, made with a loop similar to the ordinary carbon filament, had but a short life, and showed considerable blackening of the bulb. Further experiments, using wires of purer metal and more uniform character, gave continually improving results, and it became evident that the poor performance and high specific resistance which appeared with the early lamps were due to the presence of impurities, such as niobium and carbides.

After the character and quality of the material was improved it was attempted to determine the proportions for a lamp which should be suitable for standard illuminating values and voltages. Experiments with a trial lamp, having a wire 0.05 mm. in diameter, in a loop 54 mm. long, showed that an illumination of 3.5 Hefner candles was obtained, using 0.58 amperes at 9 volts, a consumption of 1.5 watts per candle power. This indicated that a similar lamp on a 110 volt system would require a filament 650 mm. long, or a little more than two feet, giving 43 Hefner candle power. Since it was desired to keep the lamp within the limits of size already employed for carbon filaments this involved some ingenuity, and Dr. Feuerlein relates in detail the efforts which were made to overcome the constructive difficulties. Among other questions the support of the wire had to be considered, since the metal becomes distinctly softer when heated, and would droop over against the inside of the bulb when the lamp was not held entirely vertical, unless firmly supported. The form finally adopted consists of a double support composed of a short glass rod with a number of radial arms standing out and up from each end, these arms having hooks at the ends, so that the wire could be reeved in and out and up and down, somewhat like the cord of a drum. This form gave a complete support of the wire, and permitted the required length to be arranged within the limited space within the bulb. A lamp of 25 Hefner candle power for a 110 volt circuit, consuming 1.5 watts per candle power, requires a filament 650 mm. in length, weighing 0.022 gramme, and at this rate about 45,000 lamps can be made from a kilogramme of tantalum. Such a lamp has a life of about 1,000 hours, and after a slight increase in efficiency for the first few hours, it maintains its illuminating power well for about 300 hours, after which there is a gradual diminution in efficiency, a 25 candle power lamp falling to 18 to 20 Hefner candles after 1,000 hours, with a consumption of a little more than 2 watts per candle.

An interesting feature of these lamps is the fact that they may be burned out several times without becoming entirely useless. This is due to the fact that a broken end will come in contact with an adjacent portion of the wire and thus re-establish the connection. The lamp will then burn more brightly, because a part of the wire is cut out of the circuit, but this also renders the failure of the remainder a matter of early occurrence.

Since Messrs. Siemens and Halske intend to manufacture these lamps for general use there will be opportunity to test its performance in a practical manner, and there is every possibility that it will take its place among the improved methods of obtaining light from electricity.

MULTIPLE EFFECT EVAPORATION.

THE PRINCIPLES INVOLVED IN THE ECONOMICAL EVAPORATION OF LIQUIDS IN SUCCESSIVE CHAMBERS.

Charles Day—Manchester Association of Engineers.

THE operation of converting a liquid into vapor by means of the heat contained in another vapor is required in many industrial processes. The heating vapor is practically always that of water, while the liquid to be evaporated varies, including sugar juices, chemical solutions, and other substances, the actual evaporation being usually that of the contained water. About the year 1830 the idea of conducting the evaporation in successive chambers was conceived by M. Rillieux, in connection with the evaporation of sugar juices, and from that it has been extended to numerous applications. In a paper recently presented before the Manchester Association of Engineers, Mr. Charles Day discusses such devices and examines the theory upon which their efficiency is based.

"Ordinary multiple effect evaporators consist of two or more vertical cylindrical vessels partaking of the character of surface condensers. Steam, either in the form of exhaust from the engines, or direct from boilers, is usually, though not necessarily, the source of heat by which the evaporation is brought about. The steam thus supplied is taken to the first of the vessels and there surrounds tubes containing the liquor to be evaporated. The pressure inside the tubes is kept lower than the pressure of the steam supplied to the casing around the tubes, consequently the boiling temperature of the liquor inside the tubes is lower than the temperature of the saturated steam outside, with the result that the steam will be condensed to water, which, however, will still be at a higher temperature than the liquor and vapour in the tubes.

"The heat thus given up will practically be the latent heat of the steam, and each pound of steam condensed will evaporate approximately 1 lb. of the water in the tubes, thus generating steam in the tubes. This steam is then conveyed by means of a suitable pipe to the calandria of the second vessel, which also contains tubes through which the liquor to be evaporated passes.

"The pressures in the second vessel and in the tubes are lower than in the first vessel and tubes respectively, hence the steam generated in the tubes of the first vessel now surrounds tubes containing a liquor at a lower temperature; it is therefore condensed, and in condensing evaporates approximately another pound of water. By this means each pound of steam supplied to the apparatus has now evaporated approximately 2 lbs. of water. If, then, the apparatus has three vessels or effects, and the pressure in the third is kept lower than the pressure in the second vessel, the steam generated in this latter can be taken to the third vessel and used to evaporate another pound of water there. This system can be carried on to 4, 5, or 6 effects, or, in fact, to as many effects as the temperature limits will allow."

Devices of this sort are used, not only to concentrate solutions, but also to act in the reverse manner and obtain pure water from solutions containing foreign matter, such as the production of pure water on shipboard from the salt sea water. In any case the important matter of the rate of heat transmission through metallic surfaces enters into the matter. This is a subject which, though much experimented upon, is still vaguely understood, and worthy of further investigation. The law enunciated by Newton, that the rate of transmission of heat is directly proportional to the difference of temperature is no longer accepted as true. Mr. Day refers to the experiments of Hagemann, at Copenhagen, which show that there is an increase in the rate of evaporation per square foot by rapid circulation of the liquid in the tubes, and doubtless this applies not only to evaporators and condensers, but also to steam boilers.

Other experimenters have found that the heat transmission per square foot is three to four times as rapid when the liquid is boiling than otherwise, which fact may explain the greatly improved output from boilers when very hot feed water is supplied to them. Possibly the advantage of live-steam feed-heaters on board ship may be largely due to this action.

Mr. Day examines the action of a Yaryan six-effect evaporator tracing the course of the liquor to be evaporated and the steam by which the evaporation is caused.

"When used for the distillation of water the impure water is drawn from the circulating water which has passed through the condenser, and which has thus been somewhat heated. It is then pumped through the first heater, then forward through the second heater, whence it passes through heating tubes in each of the six evaporating vessels of effects. By the time it has passed through the last set of heating tubes, which is contained in the first, or high temperature effect, or vessel, its temperature will not be much below the temperature of the steam supplied to that effect.

"The water formed by the condensation of the steam supplied to the first effect is usually returned direct to the boiler; thus the boiler is fed with pure distilled water at a high temperature, consequently a high evaporation per pound of coal should result and be well maintained. The steam formed in the tnbes of the first effect, together with the water, pass to a separator; there the steam is separated from the water and is led to the shell of the second effect, whilst the water passes into the tubes of this effect. The pressure in the shell of this effect practically corresponds with the pressure in the tubes of the first effect, but the pressure in the tubes of the second effect is several pounds lower, hence as the water entering the tubes is at the higher temperature of the previous effect there is immediate and spontaneous evaporation of some of the water, and this causes a lowering of the temperature of the remainder, which reduction of temperature permits of heat being transmitted through the tubes from the steam on the other side causing evaporation of a further quantity of water and the condensation of the steam outside of the tubes.

"Again the mixed water and steam pass to the separator, and the separated steam is then led to the shell of the next effect. and the water to its tubes, but as the water produced by the condensation of the steam supplied to the shell of the second effect is not wanted for boiler feeding, it is drained into the shell of the third effect, and there imparts some of its heat to the water in the tubes. Spontaneous evaporation also takes place here, owing to the water entering a vessel in which the boiling temperature of water is lower than the temperature of the incoming water.

This cycle of operations is repeated in succeeding effects until the last one is reached. From here the water drained from the second, third, fourth, and fifth effects, together with the water of condensation formed on its own tubes, is drained to the second heater, whence it passes to the condenser. The steam from the last separator passes through the safes to the first heater, where some of it is condensed, the final condensation taking place in the surface condenser, where not only does this condensation take place, but the water so formed is, along with the water drawn from the previous shells, finally cooled by the circulating water in the condenser."

Mr. Day goes at length into the computations of the output of a six-effect water distiller, showing that the production of distilled water per pound of coal is 49.2 pounds.

FUEL ECONOMY IN STEAM-POWER PLANTS.

METHODS OF SECURING COMMERCIAL ECONOMY IN THE GENERATION OF POWER FOR ELECTRIC LIGHTING AND TRACTION STATIONS.

W. H. Booth and J. B. C. Kershaw—Institution of Electrical Engineers.

IN all power stations it is the part of good management to produce the required results in the most economical manner, and since the fuel charges constitute about one-half of the total power cost it is to a reduction in fuel consumption that most managers look to effect economies. In a paper recently presented before the Institution of Electrical Engineers, Messrs. W. H. Booth and John B. C. Kershaw discuss the economical operation of electric generating stations, and an abstract of this extensive discussion is of interest.

As in other departments of work, the best efficiency in the power plant cannot be attained unless uniformity in working is secured, and this is practically impossible in either electric lighting or traction stations. The load can be equalized by the use of an accumulator battery, and this method is adopted in a number of cases, but the construction of such batteries is yet so far from being perfected that their adoption is yet a matter for independent investigation, and the authors of the paper under consideration proceeds to discuss the methods of obtaining the best economy independently of any such equalizing apparatus.

Considering only a steam-power station, the subject of economy is divided into a number of heads, including feed water, fuel, boilers and furnaces, steam, waste gases, and draught.

So far as feed water is concerned, it is now fully admitted that it is impossible to obtain the best results unless the water is properly purified and heated before it is passed into the boilers.

No general panacea can be considered, and the water should be properly analyzed in each case to enable the proper remedy to be ascertained, and subsequent analyses made at intervals to determine whether any changes in the nature of the supply have occurred. If chemical methods of softening are employed the purified water should be examined at intervals, since there is a frequent tendency to overdo the matter, and a proper check should be independently applied. Oil and grease should be separated from the water by the employment of suitable apparatus, intelligently employed, and whenever surface condensation is employed and condensed steam is returned to the boilers, or an open heater is used, an effective oil separator should form a portion of the equipment. A thin layer of scale is advantageous rather than otherwise to the boilers, since it prevents pitting and corrosion, but grease is always objectionable as well as productive of loss.

It has always been considered advantageous to heat the feed water to a point as nearly as possible to the boiling temperature, but there is a further gain secured by the use of live steam to raise the temperature of the feed water still higher than 212° F.

The advantages of using live steam for feed-water heating have been questioned, but there appears to be ample evidence that an economy may be secured by this method if it is properly done. The heat of the live steam is retained in the feed water and thus returned to the boiler, and the advantages of the higher temperature far exceed the slight loss of heat which occurs by condensation and radiation. Various theories have been advanced to account for the marked improvement in efficiency produced by live-steam heating of the feed-water, but none of these has been found wholly satisfactory, but the facts appear to be well substantiated.

A most important question is the proper adaptation of the furnace to the fuel to be burned, and in many places expensive fuel is used because it is asserted that steam cannot be kept up or that smoke is produced, when, as a matter of fact, the cheaper fuels could easily be burned in properly designed furnaces.

Boilers may be divided into three general types; the large shell type; the large water-tube type; and the small water-tube type. All three have their applications, the first being adapted for long-continued steady work, and the latter forms for less uniform demands, the last being especially suited for the peaks of loads of short duration, owing to its capacity for heavy forcing.

A marked source of loss in water-tube boilers is that of air leaks, although the loss from air infiltration has only been fairly recognized in late years. In this respect the internally-fired shell boiler has the advantage, although this is partially offset by other disadvantages. Both through cracks and directly through the brick walls of a water-tube boiler the air can be demonstrated to enter, and it is well said that glazed brick might often be better employed to case in boilers than to decorate engine rooms. It is only necessary to investigate the walls of an ordinary bricked in boiler with a lighted candle to demonstrate the suction of air through the solid walls, while the leakage through cracks is very great.

The authors are not altogether favorable to mechanical stokers, considering them unequal to the prevention of the smoke evil. It is admitted that mechanical stokers have the ability to raise steam with cheaper coal than is demanded by hand firing, besides effecting an economy in the reduction of the stoking staff. At the same time they will not be an economy unless their hoppers are filled mechanically and they ought to be in charge of a skilled mechanic to look to upkeep and maintenance, and not be expected to run with unskilled attention.

The real object of the power plant is to generate power through the medium of steam, and the production of the steam is the object of burning fuel under boilers. The best plant is that which produces the best steam to the best advantage, and this means that it should really be steam which is produced and not a mixture of steam and hot water. The fact that steam begins to lose heat as soon as it leaves the boiler renders it very necessary to protect it as much as possible against sources of loss. The best method of providing that the steam shall be saturated with heat and be at its maximum density per cubic foot for its pressure when delivered to the cylinder is to have it moderately superheated.

The questions of waste gases and of chimney draught are examined at length in the paper, and in conclusion the authors emphasise the fact that the best results can be attained only if scientific methods of control are employed in relation to feed water, fuel, waste gases, and draught.

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A Three-Hinged Concrete Steel Arch. L. A. Keith. Illustrated description of a recent construction in Mansfield, O., with account of test made of model. 1800 w. Eng Rec—Feb. 18, 1905. No. 67847.

The Computation of Arches and Suspension Bridges (Calcul des Ponts en Arc et des Ponts Suspendus). A. Considère. A mathematical examination of the stresses in arches, and their relation to similarly proportioned suspension bridges. 1800 w. Comptes Rendus—Jan. 23, 1905. No. 67919 D.

The World's Largest Concrete-Steel Arch Bridge: The Gruenwald Bridge at Munich. Gives general illustrated description and dimensions of the design of arch ribs, foundations and piers, roadway and approaches, &c. 3500 w. Eng News—Feb. 23, 1905. No. 67887.

Bridge Floors.

Concrete Floors for Railway Bridges. Illustrates and describes examples of solid floors of reinforced concrete, as used by

We supply copies of these articles. See page 159.

different railways. 900 w. Eng News—Feb. 16, 1905. No. 67805.

Cantilever.

The Moline Bridge. Illustrates and describes a riveted steel-truss through structure about 710 ft. long between centers of abutment seats, and a height of 35 ft. above the water. There are four spans, with three river piers. The bridge is somewhat remarkable on account of the proportions and arrangements of the trusses. 3000 w. Eng Rec—Feb. 11, 1905. No. 67768.

Drawings.

Filing and Indexing Tracings of Railroad Bridges. Explains a system adopted in the office of the bridge engineer of the Erie R. R. Co., New York. Ills. 2000 w. Eng Rec—Feb. 18, 1905. No. 67851.

Erection.

Bridge Launching. B. J. Forrest. A short paper on this method of erection of steel bridges. 1000 w. Can Soc of Civ Engrs—Dec. 22, 1904. No. 68001 D.

Failure.

The Suspension Bridge Failure at Charleston, West Virginia. Addison M. Scott. An illustrated account of the fall of an old suspension highway bridge, describing its construction, the place of failure, condition, &c., and giving brief history. 2000 w. Eng News—Feb. 2, 1905. No. 67629.

Missouri River.

Missouri River Bridge of the Omaha Bridge & Terminal Railway Company. Brief outline of the history of this bridge, with illustrated description of the new structure. 1000 w. R R Gaz—Vol. XXXVIII, No. 8. No. 68023.

Reconstruction.

The Replacement of Members of a Railway Truss Bridge (Streben Auswechslung mit einem Zugstangen Systeme an einer Eisenbahn-Gitterbrücke). Julius Novak. Describing the operation of replacing the struts and tie rods of an old bridge, including experimental methods of measuring existing stresses. 3500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Jan. 13, 1905. No. 67930 D.

Stresses.

The Computation of Stresses in the Blackwell's Island Bridge. R. C. Strachan. Read before the Brooklyn Engrs.' Club. A description of the stress analysis, with editorial describing the novel features of the bridge, giving points in the stress calculation. 4800 w. Eng News—Feb. 16, 1905. No. 67808.

Suspension.

A Rational Form of Stiffened Suspension Bridge. Continued discussion of paper by Gustav Lindenthal. 3000 w. Pro Am Soc of Civ Engrs—Feb., 1905. No. 68047 E.

The Bonhomme Suspension Bridge over the Blavet (Pont Suspendu du Bonhomme sur le Blavet). G. Leinekugel LeCocq. Illustrated description of highway suspension bridge of 160 metres span, near Lorient, France, with details of construction and erection. Serial. Part I. 2000 w. 1 plate. Génie Civil—Feb. 4, 1905. No. 67917 D.

Swing Bridge.

The Troïtsky Bridge at St. Petersburg (Le Pont Troïtsky à Saint Pétersbourg). Describing the manner in which electric power is applied to the operation of the swing span of the new bridge across the Neva. 1200 w. Génie Civil—Jan. 21, 1905. No. 67913 D.

Viaduct.

The New Spans of the Portage Viaduct, Erie R. R. An illustrated description of the third bridge bearing this name, giving details of reconstruction. 2000 w. Eng Rec—Feb. 4, 1905. No. 67652.

Wind Pressure.

Probable Wind Pressure Involved in the Wreck of the High Bridge Over the Mississippi River, on Smith Avenue, St. Paul, Minn., August 20, 1904. Continued discussion of paper by C. A. P. Turner. 2500 w. Pro Am Soc of Civ Engrs—Feb., 1905. No. 68049 E.

CONSTRUCTION.

Building Construction.

The Diamond Bank Building, Pittsburg. Illustrated description of a 12-story, steel-cage office building showing special features in the steel construction for the substructure, and in other details. 2200 w. Eng Rec—Feb. 18, 1905. No. 67846.

The Rapid Construction of the Baltimore-American Building. An illustrated account of the construction of a newspaper building on the site of the great fire within a year from the date of the destruction. 1400 w. Eng Rec—Feb. 18, 1905. No. 67845.

Concrete.

Concrete Construction. Edward Everett. Reviews briefly the history of the early use of concrete, the present use, reinforced concrete, government use of concrete, and gives illustrated description of plans for a concrete warehouse, tests of concrete. &c. 4500 w. Ice & Refrig—Feb., 1905. No. 67650 C.

Waterproofing Concrete Structures. W. H. Finley. Read before the Nat. Assn. of Cement Users. Gives information showing the need of waterproofing and gives specifications used by the writer with good results. 3000 w. Munic Engng—Feb., 1905. No. 67733 C.

Concrete Blocks.

The Waterproofing of Concrete Blocks. G. B. Kirwan. Read before the Nat Assn. of Cement-Users. Explains why concrete block buildings are damp, and the necessity of waterproofing. 2500 w. Munic Engng—Feb., 1905. No. 67732 C.

Dams.

A Concrete Dam on a Pile Foundation at St. John's Lake, Long Island, New York. An illustrated description of a dam and spillway founded on piles, a cut-off wall of sheet piling being used to prevent percolation through the strata into which the piles are driven. 1500 w. Eng News—Feb. 9, 1905. No. 67704.

A Quickly Erected Reinforced Concrete Dam at Fenelon Falls, Ont. Brief illustrated description of an application of concrete-steel to the construction of dams of moderate height. A dam 194 ft. long and about 10 ft. high was built in 22 ordinary working days. 700 w. Eng News—Feb. 9, 1905. No. 67705.

Grouted Rubble Core Walls for the Weirs of the Delta Barrage, Egypt. Describes the method of core wall construction of the Damietta and Rosetta weirs, built to supplement the old Delta Barrage of the Nile. Account taken from a paper by Major Sir Robert Hanbury Brown, before the Inst. of Civ. Engrs. of Gt. Britain. Ills. 4500 w. Eng News—Feb. 9, 1905. No. 67710.

The Laguna Dam, Yuma Irrigation Project, California. Information concerning a dam about to be built across the Colorado River in Arizona by the U. S. Reclamation Service. Ills. 1200 w. Eng News—Feb. 9, 1905. No. 67709.

Ferry Houses.

A Group of New Ferry Houses. Illustration and plans of the new ferry-houses for the C. R. R. of N. J., the D., L. & W. R. R., and the Erie R. R. at West 22d and 23d Sts., New York City, with brief descriptions. 500 w. R R Gaz—Vol. XXXVIII, No. 5. No. 67626.

Fireproof Buildings.

The Adjusted Fire Losses on the Fireproof Buildings at Baltimore, Md. Report of the Baltimore Convention of the National Board of Fire Underwriters, giving much information in regard to the destruction wrought to fireproof buildings by the Baltimore conflagration. 11400 w. Eng News—Feb. 9, 1905. No. 67706.

Floors.

Test of a New System of Terra-Cotta Floors. Describes a new floor construction made by the National Fireproofing Co., and to be employed throughout the floors of a system of forty warehouses now being built in Pittsburg. An illustrated description of the test made. 2000 w. Eng Rec—Feb. 25, 1905. No. 68042.

Foundations.

Construction of Foundations for the Yonkers Power House of the New York Central R. R. Information concerning foundations involving important coffer-dam and concreting work and special plant. Ills. 1800 w. Eng Rec—Feb. 11, 1905. No. 67771.

Freezing Process.

The Utilization of Artificial Cold (Etude sur l'Emploi du Froid Artificiel). E. Maynard. A discussion of the use of the freezing process for sinking foundations, with especial reference to the construction of canal locks in wet ground. 4500 w. Revue Technique—Jan. 25, 1905. No. 67925 D.

Public Works.

Time Required for the Construction of Large Public Works. Gives records of the Massachusetts Metropolitan waterworks, the New Croton system for the supply of New York City, the Boston subway, the New York Rapid Transit Railroad, the Massachusetts Metropolitan sewerage systems, and the Philadelphia filtration plants. 3000 w. Eng Rec—Feb. 4, 1905. No. 67653.

Race Track.

Planning a Modern Race Track: Belmont Park, at Queens, L. I. Describes the conditions of the topography, and the plan and location of tracks, buildings, &c. Ills. 4500 w. Eng News—Feb. 23, 1905. No. 67890.

Reinforced Concrete.

An Analysis of Concrete-Steel Construction. F. C. Slade. Aims to develop an analysis for the design of concrete-steel structures and to so put the matter in shape that it can be readily understood by the layman. 1200 w. Am Gas Lgt Jour—Feb. 6, 1905. No. 67616.

A Reinforced-Concrete Machine Shop in Philadelphia. Illustrated detailed description of the Hugo Bilgram machine shop, and its construction. 1400 w. Eng Rec—Feb. 4, 1905. No. 67656.

I. Re-enforced Concrete. Robert A. Cummings. II. A Comparison of Reinforced Concrete Formulas. L. D. Cornish. Two short papers discussed together. 3900 w. Pro Engrs' Soc of W Penn—Jan., 1905. No. 67797 D.

Scheme for a Tunnel in Reinforced Concrete (Projet de Tunnel Tubulaire en Béton Armé). Ch. Dantin. Describing a system for tube-tunnel lining of light structural skeleton imbedded in concrete. [illegible] w. Genie Civil—Jan. 28, 1905. No. 67916 D.

The Extensibility of Reinforced Concrete (Faculté que le Béton Armé Possède de Supporter de Grands Allongements). A. Considère. A review of experimental tests confirming the author's contention as to the great increase in extensibility given to concrete by reinforcement. 1500 w. Comptes Rendus—Jan. 30, 1905. No. 67926 D.

See also Civil Engineering, Bridges.

Roads.

Broken-Stone Roads. Reginald Ryves. A study of the method of constructing roads, the materials used, the effect of water, &c. 2200 w. Engng—Jan. 20, 1905. Serial. 1st part. No. 67543 A.

Data on Roads and Pavements in Iowa. Abstract of the report of the Committee on Roads and Pavements, presented at the meeting of the Iowa Engineering Society. 1800 w. Eng News—Feb. 9, 1905. No. 67707.

Sidewalks.

Practical Work of Constructing Sidewalks. A. T. Gridley. Read before the Nat. Assn. of Cement Users. Gives specifications and considers some of the requisites of good work, materials, methods, &c. 2500 w. Munic Engng—Feb., 1905. No. 67731 C.

Tunnelling.

Compressed-Air Power Plants for the Pennsylvania Railroad Tunnel. A general description of the four Ingersoll-Sergeant plants installed in connection with the tunnelling operations under the North and the East rivers at New York. 1200 w. Compressed Air—Feb., 1905. No. 67978.

The Geological Predictions for the Simplon Tunnel (Ueber die Geologische Voraussicht beim Simplon Tunnel). A comparison of the indications given by the geological commission, with those actually revealed by the boring. 3000 w. Schweiz Bauzeitung—Jan. 28, 1905. No. [illegible]

MATERIALS OF CONSTRUCTION.

Brick.

The Survival of the Fittest—Brick Tried by Fire and Not Found Wanting. Albert D. Klein. Read before the Nat. Brick Mfrs.' Assn. Remarks on the effect of the Baltimore fire upon brick as a building material. 1800 w. Brick—Feb., 1905. No. [illegible]

Cement.

Cement Posts. J. A. Mitchell. Read before the Nat. Assn. of Cement Users. Gives the writer's views of cement posts which are based on an experience of over three years in the manufacture of them. 1500 w. Munic Engng—Feb., 1905. No. 67734 C.

The Dry Mixture of Cement. A. L. Goetzmann. Read before the Nat. Assn. of Cement Users. Considers the dry mixture and the manufacture of concrete blocks under this method, outlining the methods for cement testing and mixing. 3800 w. Munic Engng—Feb., 1905. No. 67730 C.

Cement Kilns.

The Efficiency of Waste Gas Boilers in Connection with Rotary Cement Kilns. A. B. Helbig. An illustrated article aiming to prove that the waste gas boiler solves the fuel problem of the cement mill. 4500 w. Eng News—Feb. 16, 1905. No. 67806.

Clay.

Fire Test and Analysis of Clay. Dr. J. Ohly. Directions for testing to determine the valuation for the making of brick or similar material. 700 w. Min Rept—Feb. 16, 1905. No. 67855.

The Testing of Clay. Prof. Edward Orton, Jr. Read before the Nat. Brick Mfrs.' Assn. Considers chemical testing and empiric testing. 8500 w. Brick—Feb., 1905. No. 67841.

Laboratory.

The Laboratory for the Testing of Road Materials at Columbia University. A. Black. Describes the methods of testing these materials in various laboratories, and the qualities required; and gives tabulated report of tests made at the laboratory of Columbia Univ., and illustrations of machines. 6600 w. Sch of Mines Qr—Jan., 1905. No. 68009 D.

Sand.

Mortar Sand. J. C. Hain. Calls attention to the peculiarities of some sands, comparing their laboratory tests with a standard. 4000 w. Munic Engng—Feb., 1905. No. 67735 C.

Timber.

A Criticism of Some Timber Specifications. Gives quotations from current specifications, with criticisms, and also quotations from rules of a lumber association, with remarks. 5000 w. Eng News—Feb. 23, 1905. No. 67889.

Timber Preservation Experiments in Texas. Abstract of a report on the condition of treated timbers laid in Texas, February, 1902. By Hermann von Schrenk. Published by the Bureau of Forestry. 4500 w. R R Gaz—Vol. XXXVIII, No. 7. No. 67834.

MEASUREMENT.

Stresses.

Note on the Summation of Stresses in Certain Structures. Carl Hering. States the problem and the results of an investigation, giving illustrations. 1800 w. Pro Engrs' Club of Phila—Jan., 1905. No. 68008 D.

Surveying.

Photographic Methods on the Canadian Topographical Survey. Abstract of a paper by Arthur O. Wheeler, read before the Canadian Congress explaining a very interesting method of surveying. 3000 w. Eng Rec—Feb. 18, 1905. No. 67853.

MUNICIPAL.

New York City.

The Development of the City. An illustrated account of the proposed improvements recommended by the commission appointed by Mayor McClellan. 4000 w. Munic Jour & Engr—Feb., 1905. No. 67596 C.

Parks.

Parks and Parkways. Andrew Wright Crawford. Notes on the park systems of various American cities, with maps and illustrations. 2800 w. Pro Engrs' Club of Phila—Jan., 1905. No. 68005 D.

Pavements.

Brick Pavements. John W. Fulwider. Read before the Indiana Engineering Soc. Gives the writer's views in regard to highway construction and describes the laying of brick pavements, sidewalk construction, &c. 800 w. Munic Engng—Feb., 1905. No. 67729 C.

The Cost of Pavement Openings in New York City. Wisner Martin. Read before the Municipal Club of Brooklyn. Especially discusses the cost of making the openings and repairing, as an argument in favor of the construction of pipe galleries. 2200 w. Eng News—Feb. 23, 1905. No. 67888.

The Good Roads Movement and the Part Paving Brick Should Have in It. R. W. Richardson. Read before the Nat. Brick Mfrs.' Assn. Considers brick road building, the method of construction, cost, and maintenance and related matters. Ills. 2800 w. Brick—Feb., 1905. No. 67843.

What Are the Relative Merits of Cement and Asphalt Fillers for Brick Pavements? H. C. Innes. Read before the Nat. Brick Mfrs.' Assn. A discussion of the proper filler for brick and block pavements. 3700 w. Brick—Feb., 1905. No. 67842.

Refuse.

Refuse Destructors. A report on tests carried out by the Manchester Steam Users' Association, under the supervision of C. E. Stromeyer. 2000 w. Elec Engr, Lond—Jan. 27, 1905. No. 67678 A.

The Municipal Refuse Destructor at Hard, Zurich (Die Städtische Kehrichtverbrennungsanstalt im Hard in Zurich). J. Fluck. Illustrating and describing the design and operation of the refuse disposal plant at Zürich. Two articles. 4000 w. Schweiz Bauzeitung—Jan. 21, Feb. 4, 1905. No. 67964 each B.

Sewerage.

The Sewerage and Drainage Systems of Wheaton, Ill. William B. Ewing. An account of the construction of a system of sewerage and drainage with a septic tank. 1500 w. Eng News—Feb. 2, 1905. No. 67630.

Sewer Farm.

The Pasadena, Cal., Sewer Farm. T. D. Allin. A description of the simple method of sewage disposal which has proved satisfactory from a sanitary standpoint, and remunerative from a financial standpoint. 2200 w. Eng Rec—Feb. 11, 1905. No. 67767.

Sidewalks.

Stone and Brick Sidewalks. J. C. Herring. Directions for the construction of natural stone sidewalks, brick sidewalks, and hexagon block sidewalks. 1800 w. Munic Engng—Feb., 1905. No. 67727 C.

WATER SUPPLY.

Filtration.

A New Form of Filter Gallery at Nancy, France. E. A. Gieseler. An illustrated account of the method of Dr. Imbeaux for remodeling the existing filter gallery at Nancy. 1800 w. Eng Rec —Feb. 11, 1905. No. 67765.

Progress in the Filtration of Public Water Supplies. Charles Brossmann, Jr. Read before the Indiana Engng. Soc. A discussion of the methods of purification, the efficiency of filtration, &c. 3000 w. Munic Engng—Feb., 1905. No. 67728 C.

The Revised Plans for the Purification of the Pittsburg Water Supply. Illustrated description of a proposed plant, one of the largest in the world, noting the unusual features. 4800 w. Eng Rec —Feb. 4, 1905. No. 67655.

The Water Filtration Works at Anderson, Ind. F. B. Leopold. An illustrated detailed description of the plant and its equipment with Jewell filters. 2500 w. Eng Rec—Feb. 4, 1905. No. 67654.

Irrigation.

A Private Irrigation System in Texas. Illustrated detailed description of a system furnishing water to an area of about 15,000 acres, and costing about $1,000,000. 1400 w. Eng Rec—Feb. 18, 1905. No. 67850.

Pumping Plant.

The New Well and Hydraulic Pumping Plant at Peoria, Ill. Dabney H. Maury. Read before the Illinois Soc. of Engrs. & Surveyors. Illustrates and describes the construction work and the plant. 2000 w. Eng Rec—Feb. 4, 1905. No. 67657.

Purification.

Copper Sulphate and Copper Foil or Copper Vessels for the Treatment of Typhoid-Infected Water. Gives statements by Dr. George T. Moore and Prof. Henry Kraemer in regard to the use of copper or copper compounds as a germicide in potable water. 1600 w. Eng News—Feb. 9, 1905. No. 67708.

The West Riding Rivers Bill. A discussion of the bill to prevent the pollution of streams by trade effluents. 3600 w. Engng—Feb. 3, 1905. Serial. 1st part. No. 67783 A.

Salt Water.

The Use of Salt Water for Fire Protection and Other Purposes at U. S. Navy Yards. Brief descriptions of the systems installed at Norfolk, New York, Puget Sound, and Key West. 2200 w. Eng News—Feb. 2, 1905. No. 67627.

WATERWAYS AND HARBORS.

Canals.

The Canal of the Two Seas (Le Canal des Deux-Mers). Francis Marre. A discussion of the project to cut a canal from Bordeaux, on the Atlantic to Narbonne, on the Mediterranean. Serial. Part I. 4500 w. Revue Technique—Jan. 10, 1905. No. 67922 D.

The Panama Canal and Its Problems. John Barrett. Considers the responsibility of Chief Engineer Wallace, a sea-level or high-level canal, projects for dams and artificial lakes, the securing of competent labor, &c., &c. 7500 w. Rev of Revs—Feb., 1905. No. 67563 C.

Crane.

Floating Shears for the Port of Riga (Bigue Blottante du Port de Riga). Illustrated description of floating pontoon carrying a 65 ton shears and a 7 ton radial crane. 1000 w. 1 plate. Génie Civil—Jan. 28, 1905. No. 67915 D.

Harbor Improvement.

The Improvement of the Port of Manzanillo, Mexico. An illustrated account of a work involving an expenditure of some seven million dollars, on the Pacific coast of Mexico. The work involves the construction of a breakwater, a stone seawall with ten piers, and a canal. 3000 w. Eng News—Feb. 16, 1905. No. 67803.

Nile.

The Navigation of the Nile. Sir William H. Preece. Deals principally with the navigation from Aswan to the sea, the regulation of the currents, depth of water, channels and banks, so that boats may pass up and down stream in all seasons. Discussion. 7000 w. Jour Soc of Arts—Feb. 3, 1905. No. 67777 A.

Regulation.

The Compensating Works of the Lake Superior Power Company. G. F. Stickney. Illustrated description of regulating works including an embankment, a movable dam, a crib dam, and a submerged weir. 6000 w. Pro. Am Soc of Civ Engrs—Feb., 1905. No. 68046 E.

Water Flow.

The Determination of the Normal Profile of Flowing Water (Studie über die Bestimmung der Normalprofile Geschiebeführender Gewässer). Richard Siedek. A study of the relation of the sectional figure of a stream bed and the eroding action of the water flow. Serial. Part I. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Feb. 3, 1905. No. 67931 D.

The Parabolic Method of Computing Steam Gagings. F. W. Hanna. Explains an application of Simpson's one-third rule to the computation of stream gagings, both for open and frozen streams. 1200 w. Eng News—Feb. 9, 1905. No. 67711.

Wave Action.

Wave Action in Relation to Engineering Structures. D. D. Gaillard. Greatly condensed from Professional Paper No. 31 of the Corps of Engineers, U. S. A. A study of wave action, the effects upon breakwaters and similar structures, &c. Ills. 4700 w. Eng News—Feb. 23, 1905. No. 67885.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The New Canal Telephone Exchange at Cincinnati, Ohio. J. E. Peavey. Illustrated description. 1300 w. Elec Rev, N. Y.—Feb. 4, 1905. No. 67623.

Space Telegraphy.

The Development of Wireless Telegraphy. Samuel J. Plimpton. An outline aiming to show how the physicist has been related to the engineer in developing space telegraphy. 2000 w. Yale Sci M—Jan., 1905. No. 67773 C.

Trees as Antennæ in Wireless Telegraphy. A. Frederick Collins. Illustrations with description of experiments by George O. Squire, Major Signal Corps, U. S. A. 1600 w. Sci Am—Feb. 11, 1905. No. 67713.

Wireless Telegraphy and War Correspondence. Captain Lionel James. An account of the excellent results obtained with the De Forest system in reporting incidents of the war in the East. General discussion. 7500 w. Jour Soc of Arts—Jan. 20, 1905. No. 67526 A.

Wireless Telegraphy Experiments at the Eiffel Tower. Emile Guarini. Brief account of experiments made and proposed. Ills. 1700 w. Sci Am Sup—Feb. 25, 1905. No. 67891.

Telegraph Call.

A Selective Call for Morse Telegraph Systems (Der Wahlweise Anruf in Ruhestrom Morseleitungen). J. Baumann. Describing methods of using either continuous or alternating currents for calls over telegraph lines. 3500 w. Elektrotech Zeitschr—Jan. 26, 1905. No. 67954 B.

Telegraphy.

Breaks in Overland Telegraphic Communication Due to Storms. William Maver, Jr. Discusses some proposed remedies. 3300 w. Cassier's Mag—Feb., 1905. No. 67667 B.

Through Wheatstone Working Over a Line of 4,000 Miles. T. W. Stratford-Andrews. Concerning the Indo-European telegraph line; some of the difficulties met with, method of working, &c. Map. 1600 w. Elec Rev, Lond—Jan. 20, 1905. No. 67534 A.

DISTRIBUTION.

Cables.

Some Points on the Selection of Electric Cables. L. B. Atkinson and C. J. Beaver. Abstract of a paper read before the Manchester Sec. of Elec. Engrs. Deals with the subject from the standpoint of the buyer and user, describing the insulation of cables principally. Short discussion. 4800 w. Elec Engr, Lond—Feb. 10, 1905. No. 67870 A.

The Heat Conductivity of Twisted Cables (Ueber die Wärmeleitung in einem Verseilten Kabel). Gustav Mie. A mathematical examination of the transmission of heat through cables made up of several strands, deducing precise and approximate formulas. 6000 w. Elektrotech Zeitschr—Feb. 6, 1905. No. 67959 B.

Comparison.

Direct Current versus Alternating Current Distribution. O. M. Rau. Read before the Northwestern Elec. Assn. Compares the efficiencies of the two systems, the cost of installation, &c., concluding in favor of the alternating current. 1800 w. Elec, N. Y.—Feb. 1, 1905. No. 67562.

Costs.

Distribution and Dollars. C. H. Williams. Read before the N.-W. Elec. Assn. An analysis of the factors that affect the cost of distribution, the losses to be guarded against, &c. 6800 w. Elec Rev, N. Y.—Feb. 11, 1905. No. 67749.

Madison, Wis.

Central Station Distribution. Full abstract of paper by C. H. Williams, read before the Northwestern Electrical Assn., describing practice in Madison, Wis., and discussing good practice. 3000 w. Elec Wld & Engr—Jan. 28, 1905. No. 67561.

Motor-Generator.

Some Tests Conducted With an Electrolytic Rectifier and Motor-Generator. Horace Boot. An illustrated account of comparative tests of the electrolytic rectifier *v.* an alternating current motor driving a direct current dynamo, for the purpose of charging the accumulators of a large electric car. 1500 w. Elec Rev, Lond—Feb. 10, 1905. No. 67871 A.

Overhead Mains.

The Value of Overhead Mains for Electric Distribution in the United Kingdom. G. L. Addenbrooke. An investigation of the overhead distribution problem, its cost, advantages, &c. Also an appendix giving the Italian law for the transmission to a distance of electric currents. 12300 w. Inst of Elec Engrs—Feb. 9, 1905. No. 67873 D.

South Wales.

District Electric Power Distribution. An illustrated description of the system of the South Wales Electric Power Distribution Company, especially describing the Treforest power house and its equipment. Also the sub-stations. 2800 w. Elec Wld & Engr—Jan. 28, 1905. No. 67558.

Sub-Station.

The Fisher-Street Sub-Station of the Metropolitan Electric Supply Co. Illustrated description of the largest sub-station with rotary machinery, running in England. Its present capacity is 3,000 kw., and it is to be increased to 5,000 kw. Its interesting features are noted. 3000 w. Elect'n, Lond—Jan. 20, 1903. No. 67538 A.

Switchgear.

A British Switchgear for Sub-Station Control. Illustrated description of the switch gear of the Fisher Street sub-station, London. 5000 w. Elec Wld & Engr—Feb. 18, 1905. No. 67864.

ELECTRO-CHEMISTRY.

Electric Furnaces.

Resistance Furnace for Crucibles. Francis A. J. FitzGerald. Describes the general methods of construction of a crucible furnace, and compares it with a commercially worked furnace, giving experiments. Ills. 4200 w. Elec-Chem & Met Ind—Feb., 1905. No. 67620 C.

The Electric Furnace in the Iron and Steel Industry. Auguste J. Rossi. A letter discussing the metallurgical side of the question, the cost, &c. 1700 w. Elec-Chem & Met Ind—Feb., 1905. No 67619 C.

Electro-Metallurgy.

Electro-Metallurgy in 1904. A survey of the year's progress in these industries. 2500 w. Engr, Lond—Feb. 10, 1905. No. 67882 A.

Electroplating.

Electroplating. Herbert J. Hawkins. An explanation of up to date methods. 1200 w. Met Work—Feb. 18, 1905. Serial. 1st part. No. 67817.

Progress.

Progress in Electro-Chemistry and Electro-Metallurgy in 1904. John B. C. Kershaw. A review in detail. 1800 w. Elec Rev, Lond—Jan. 20, 1905. Serial. 1st part. No. 67537 A.

ELECTRO-PHYSICS.

Cast Iron.

The Magnetic Properties of Cast Iron (Magnetische Eigenschaften des Gusseisens). H. Nathusius. Data and results of investigations into the permeability, remanence, and other magnetic properties of cast iron with relation to the chemical constitution. Serial. Part I. 2500 w. Stahl u Eisen—Jan. 15, 1905. No. 67936 D.

Electric Waves.

The Schloemilch Wave Detector. Illustrated description of an apparatus devised by W. Schloemilch, based on the sensitiveness of polarization cells to electric waves. 1400 w. Sci Am Sup—Feb. 18, 1905. No. 67813.

Wave Distortion on Transmission Lines. William S. Franklin. Abstract of a lecture before the N. Y. Elec. Soc. A discussion of the wave piston, with diagrams. 2500 w. Elec Rev, N. Y.—Feb. 11, 1905. No. 67751.

Electromotive Force.

The Computation of the Effective Electromotive Force of Polyphase Machines (Ueber die Berechnung der Effektiven Elektromotorischen Kraft von Drehstrommaschinen). Arthur Müller. A mathematical investigation, deriving formulas, and computing a table of factors for a three-phase alternator. 2000 w. Zeitschr f Elektrotechnik—Jan. 15, 1905. No. 67961 D.

Fog Dispersion.

Fog Dispersion by Electricity. Describes the process worked out by Sir Oliver Lodge, illustrating the apparatus used. 1800 w. Sci Am—Feb. 11, 1905. No. 67712.

Magnetization.

The Conversion of Energy in the Magnetization and Electrification of Media (Energieumwandlung während der Magnetisierung und Elektrisierung von Medien). Dr. Johann Sahulka. A mathematical study based upon experiments with permanent magnets and with electrical condensers. 5000 w. Elektrotech Zeitschr—Feb. 2, 1905. No. 67957 B.

Radioactivity.

A New Radioactive Mineral (Sur un Nouveau Minéral Radifère). J. Danne. Describing radioactive minerals containing lead, discovered near Issy-l'Evêque, in France, the principal one being pyromorphite, containing no uranium. 800 w. Comptes Rendus—Jan. 23, 1905. No. 67920 D.

The Radioactive Deposits at Issy l'Evêque (Les Gisements Radifères d'Issy l'Evêque). Jacques Danne. Describing deposits of argile, permatite, and pyromorphite, minerals containing lead and no uranium, but having a marked radioactivity. 1500 w. Génie Civil—Jan. 21, 1905. No. 67912 D.

GENERATING STATIONS.

American Plants.

Description of Some Plants Inspected During a Recent Visit to the States. H. L. Risley. Describes apparatus that appeared to differ from British practice, especially single-phase traction motors. 3600 w. Elec Engr, Lond—Jan. 20, 1905. No. 67533 A.

Armatures.

Armature Winding for Constant Potential Direct-Current Machinery. Illustrates and describes the types of standard windings. 2500 w. Elec Club Jour—Feb., 1905. No. 67823.

Armature Windings of the Closed Circuit Type. William Cramp. An illustrated series of articles examining reentrant windings. 1400 w. Elec Engr, Lond—Jan. 20, 1905. Serial. 1st part. No. 67531 A.

California.

The Power Plants of the Edison Electric Company of Los Angeles. The first of a series of articles giving illustrated descriptions of the hydroelectric and the steam stations of this extensive system for supplying light and power in seven counties of Southern California. 3200 w. Eng Rec—Feb. 25, 1905. Serial. 1st part. No. 68038.

Chattanooga, Tenn.

The Power Plant of the Chattanooga Electric Company, Chattanooga, Tenn. Illustrates and describes an important addition. with the installation of Curtis steam turbines. and other novel features. 1800 w. Elec Rev, N. Y.—Feb. 25, 1905. No. 68035.

Chelsea.

The Chelsea Generating Station of the London Underground Railways. An illustrated description of this power station. 2000 w. Eng Rec—Feb. 25, 1905. No. 68040.

Commutators.

Refilling and Repairing Commutators. Arthur B. Weeks. Gives an instance illustrating the importance of using the best material, describing methods of repair. 1600 w. Am Elect'n—Feb., 1905. No. 67614.

Cut-Outs.

Discriminating Relays and Cut-Outs: A Reply to Mr. M. B. Field. Leonard Andrews. A critical discussion of devices for isolating a faulty generator. 1800 w. Elec Rev, Lond—Feb. 3, 1905. No. 67781 A.

Detroit.

Central Station Work in Detroit. Begins an illustrated description of a large central generating plant with its equipment and the use of steam engines at certain sub-stations, and the supply of steam heat from these stations, and other features of interest. 4500 w. Elec Wld & Engr—Feb. 4, 1905. Serial. 1st part. No. 67658.

Dynamos.

Development of the Unipolar Dynamo. James Asher. Brief review of the development in unipolar dynamos since 1831, describing briefly the types. 1100 w. Elec Wld & Engr—Feb. 4, 1905. No. 67659.

Hartford.

The Dutch Point Plant of the Hartford Electric Light Company. Illustrated detailed description of a steam-turbine electric central station of 4,000 kw. rated capacity, interesting because of its rapid erection and because of details in design, arrangement of turbine and boiler rooms, and systems of steam piping. 3500 w. Eng Rec—Feb. 25, 1905. No. 68036.

High-Tension.

A Recent High-Tension Installation. A. E. Buchenberg. Illustrates and describes a recent electrical high-tension plant installed at Martinsburg, W. Va. 1500 w. Engr, U. S. A.—Feb. 15, 1905. No. 67835 C.

Hydro-Electric.

A Norwegian Hydro-Electric Plant. Brief illustrated description of a new plant at Christiania, Norway. 1800 w. Elec Wld & Engr—Feb. 11, 1905. No. 67762.

Construction of Canadian Niagara Power Company's 100,000 H. P. Hydro-Electric Plant at Niagara Falls, Ont. Cecil B. Smith. Illustrated detailed description of the construction and equipment. 9 plates. 8500 w. Can Soc of Civ Engrs—Jan., 1905. No. 67899 D.

Opening of the Niagara Canadian Power Company's Plant. An illustrated account of the starting of the initial units of this plant. 1100 w. Sci Am—Feb. 4, 1905. Serial. 1st part. No. 67660.

The Hohenfurth Electric Station of Spiro & Sons (Elektrizitätswerk Hohenfurth der Firma I. Spiro & Söhne in Krumman). Dr. J. Puluj. Fully illustrated description of a plant taking 2.300 h. p. from the Moldau and transmitting it to the Spiro paper mills, 25 kilometres distant. 3500 w. Zeitschr f Elektrotechnik—Jan. 22, 1905. No. 67962 D.

The Hyrdo-Electric Power Plant of the North Mountain Power Co. An illustrated detailed description of a twenty-five cycle installation which is to serve Humboldt Bay and Eureka, in California. 3000 w. Jour of Elec—Feb., 1905. No. 67798 C.

The Successful Joint Utilization of Several Small Water Powers. W. B. Jackson. Remarks on recent changes with respect to sources of power, describing the system of the Janesville Electric Company which has details of interest. 2200 w. Am Gas Lgt Jour—Feb. 13, 1905. No. 67755.

Indian Territory.

The Gas and Electric Plant at Muskogee, I. T. Brief illustrated description of a gas and electric and ice plant installation. 700 w. Elec Rev, N. Y.—Feb. 11, 1905. No. 67750.

Isolated Plant.

Mechanical Plant of a Power Building in Providence, R. I. Illustrated description of the plant for furnishing heat, light, and power for a five-story mill-construction building. 1800 w. Eng Rec—Feb. 11, 1905. No. 67770.

The Electrical Equipment of the Hotel Astor, New York. W. E. Crane. An illustrated detailed description of the engineering equipment of this fine hotel, especially the electrical plant. 2500 w. Elec Wld & Engr—Feb. 11, 1905. No. 67761

Load Factor.

Effect of Load Factor on Cost of Power. Abstract of a paper by E. M. Archibald, read before the Canadian Soc. of Civ. Engrs. Discusses the effect of load factor on the cost of producing power, the cost of management, and distribution. 2500 w. Elec Wld & Engr—Feb. 11, 1905. No. 67764.

The Influence of "Load-Factor" on the Cost of Electrical Energy. Edmund L. Hill. Gives an explanation of the meaning of "load factor" showing its effect on the economy of the system. 3300 w. Elect'n, Lond—Feb. 10, 1905. No. 67874 A.

Munich.

The Electric Plants of the City of Munich (Die Elektrizitätswerke der Stadt München). K. Meyer. A general description of the electric generating and transforming stations in Munich. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 14, 1905. No. 67900 D.

Providence, R. I.

The Narragansett Electric Lighting Company's Plant. Illustrated detailed description of the plant which supplies current for light and power to the city of Providence, R. I., and the territory included in a circle of about fifteen miles radius. 2800 w. Elec Rev, N. Y.—Feb. 11, 1905. No. 67748.

Switchboards.

Accuracy Checks of Switchboard Instruments. Clayton H. Sharp. Considers the derangements liable to occur in switchboard instruments and the necessity for periodic checking, and the methods. 2800 w. Elec Rev, N. Y.—Feb. 11. 1905. No. 67752.

Switchboard Connections of Compound-Wound Generators. H. M. Gassman. Discusses the scheme of connections. Ill. 500 w. Am Elect'n—Feb., 1905. No. 67615.

Transformer Oil.

Some Hints About Transformer Oil. C. E. Skinner. Directions for filling transformer cases with oil. 1500 w. Elec Club Jour—Feb., 1905. No. 67824.

LIGHTING.

Arcs.

Series Alternating Arc Lighting. E. P. Warner. Read at the convention of the Northwestern Elec. Assn., at Milwaukee, Wis. Considers the requirements of a modern system of arc lighting, the desirable features in the series alternating lamp, and the results achieved. 3700 w. Elec Rev, N. Y.—Feb. 4, 1905. No. 67625.

The Light Emission from the Arcs of Intensive Arc Lamps (Ueber die Lichtausstrahlung von Lichtbögen in Intensivbogenlampen). Berthold Monasch. An examination of the distribution of illumination from arc lamps with impregnated carbons arranged in an inclined position. 5000 w. Elektrotech Zeitschr—Jan. 19, 1905. No. 67951 B.

Illumination.

Progress in the Technology of Illumination (Fortschritte in der Beleuchtungstechnik). Dr. W. Wedding. An address before the Electrical Society of Cologne, reviewing the development of the latest forms of oil, gas, and electric lighting, with a comparison of their relative efficiency. 3500 w. Elektrotech Zeitschr—Jan. 19, 1905. No. 67953 B.

London Coliseum.

The London Coliseum. An illustrated article describing the electric equipment of a large place of amusement, especially the stage lighting and power. 4000 w. Elect'n, Lond—Jan. 27, 1905. No. 67684 A.

Nernst.

The Nernst Lamp. E. R. Roberts. Explains the principle of this lamp giving information concerning its recent development. General discussion. 4000 w. Pro Engrs' Soc of W Penn—Jan., 1905. No. 67795 D.

Tantalum Lamp.

Tantalum and the Tantalum Lamp. Gives information of an investigation carried out by Dr. W. von Bolton, of the preparation and properties of pure tantalum which has a very high melting point, discussing the chemical side of the subject. 800 w. Elec-Chem & Met Ind —Feb., 1905. No. 67618 C.

The New Tantalum Lamp of Siemens & Halske (Die Tantallampe eine Neue Glühlampe der Firma Siemens & Halske A. G.). W. von Bolton & O. Feuerlein. With illustrations of the incandescent lamp using tantalum as the luminous element. Data of illumination and endurance are given. 4000 w. Elektrotech Zeitschr—Jan. 26, 1905. No. 67956 B.

The Tantalum Incandescent Lamp. A detailed account of a new lamp in which tantalum is used for the filament. Editorial comment. Ills. 4000 w. Elec Wld & Engr—Jan. 28, 1905. No. 67560.

The Tantalum Lamp of Messrs. Siemens & Halske. Dr. W. v. Bolton and Dr. O. Feuerlein. Abstract of a paper read before the Elektrotechnische Verein at Berlin. An account of the experimental investigations, and an illustrated description of the tantalum lamp, its electric and photometric properties, and its behavior in actual use. 4000 w. Elec Rev, Lond—Jan. 27, 1905. No. 67682 A.

The Tantalum Lamp (Die Tantallampe). E. Budde. A brief description of the Siemens & Halske tantalum incandescent lamp, with data of performance. 2000 w. Zeitschr f Elektrotechnik—Jan. 29, 1905. No. 67963 D.

MEASUREMENT.

Calibration.

Calibration of Voltmeters and Ammeters. L. A. Freudenberger. Describes a method particularly applicable to voltmeters of the double-scale type. 1500 w. Elec Wld & Engr—Feb. 11, 1905. No. 67763.

Electrical Waves.

De Forest-Ives Electric Wave-Length Standard. A. Frederick Collins. Illustrated description of instrument and its operation. It is said to be capable of measuring any length of wave employed in the present practice of wireless telegraphy. 1500 w. Sci Am Sup—Feb. 4, 1905. No. 67663.

Electroscopes.

The Construction of Simple Electroscopes for Experiments on Radioactivity. O. W. Richardson. An illustrated description of simple electroscopes. 2200 w. Nature—Jan. 19, 1905. No. 67525 A.

Losses.

The Retardation Method of Measuring Losses in Electric Motors and Generators. Frederick W. Seringhaus, Jr., and Gerard B. Werner. Gives in detail the results of an investigation of this method, made at Columbia Univ. 2000 w. Sch of Mines Qr—Jan., 1905. No. 68010 D.

Oscillograph.

Kinematic Representation of Current Curves by Means of the Luminous Discharge Oscillograph (Kinematographische Aufnahmen einiger Stromkurven mittels Glimmlicht-Oscillographen). Ernst Ruhmer. Describing an instrument using the luminous effect in a Geissler tube for showing the phase action of the current. 1800 w. Elektrotech Zeitschr—Feb. 9, 1905. No. 67960 B.

Self-Inductance.

Measurements of Self-Inductance. J. B. Whitehead and H. D. Hill. Reports investigations made of the methods for the measurement and comparison of self-inductance capacity and mutual inductance published by Prof. Rowland, to determine their value. 3800 w. Am Jour of Sci—Feb., 1905. No. 67589 D.

Wattmeters.

Null Wattmeter Methods of Measuring Power. Albert Campbell. Brief description of two novel methods of measuring power. 700 w. Elec Rev, Lond—Jan. 27, 1905. No. 67680 A.

The Choice of Signs in Wattmeter Problems. L. A. Freudenberger. Giving rules for constructing vector diagrams from the wattmeter readings to enable the values and phase positions of the currents in a three-phase network to be determined. 1400 w. Elec Wld & Engr—Feb. 18, 1905. No. 67866.

MOTORS.

"Balancer."

The "Balancer" as Employed in Multiple-Voltage Direct-Current Systems. A. E. Kennelly. Describes the balancer and its general arrangement and applications for effecting speed control of motors in the shop. 1500 w. Harvard Engng Jour —Jan., 1905. No. 67598 C.

Brewery Plant.

Power Plant of the Anheuser-Busch Brewing Association at St. Louis. Illustrates and describes a plant with a capacity of 1,400 kilowatts, to furnish power for direct-current motors which drive the various machines, and for lighting. 1500 w. Engr, U. S. A.—Feb. 1, 1905. No. 67610 C.

Diagram.

A Working Diagram of the Alternating Current Synchronous Motor. A. E. Kennelly. Gives a graphical method of representing the relations between the e. m. f.'s, currents and power in a single-phase synchronous-motor circuit, applicable to three-phase motor systems. Also editorial. 2000 w. Elec Wld & Engr—Jan. 28, 1905. No. 67559.

Electric Driving.

An Electrically Driven Flour Mill. O. C. McMeans. Read before the Indiana Engng. Soc. Describes the equipment of the flouring mill plant of the Urban Milling Co., of Buffalo, which uses power from Niagara. 2000 w. Eng Rec—Feb. 11, 1905. No. 67766.

Electric Drive. E. L. Walker. A discussion of variable speed motors and the methods of applying them to machine tools. Also general discussion. Ills. 5600 w. Pro Engrs' Club of Phila—Jan., 1905. No. 68006 D.

The Electrical Operation of Textile Factories. H. W. Wilson. Abstract of a paper before the Manchester Sec. of the Inst. of Elec. Engrs. States the advantages claimed for electrical driving, discussing cost, reliability, &c. 3000 w. Prac Engr—Jan. 27, 1905. Serial. 1st part. No. 67676 A.

Induction Motors.

A New Design for Slow Speed Induction Motors. Prof. Clarence P. Feldmann. Brief illustrated description of a German design of a double motor for draining pumps in mines. 700 w. Elec Wld & Engr—Feb. 18, 1905. No. 67865.

Magnetic Brake.

Design for a Magnetic Brake for a 15 Horse-Power, 500-Volt Motor. R. A. Greene. Section, and description. 1200 w. Am Mach—Vol. 28, No. 8. No. 68017.

Motor Equipments.

Two-Motor versus Four-Motor Equipments. N. McD. Crawford. A report of an investigation made, describing the line and conditions of service on which the tests were made. 1200 w. Am Inst of Elec Engrs—Feb. 24, 1905. No. 68002.

Regulation.

Some Tests on the Use of the Synchronous Motor in Compensating for Lagging Currents in a Circuit. E. A. Regestein. Explains the considerations involved and describes tests made by the writer. 1800 w. Elec Rev, N. Y.—Feb. 25, 1905. No. 68034.

Repulsion Motor.

A New Repulsion Motor and its Preliminary Computations (Ein Neuer Repulsions-Motor und Seine Vorausberechnung). Karl Schnetzler. A discussion of the problems connected, the windings, the position of the brushes, and the dimensions for required power and regulation. Two articles. 6000 w. Elektrotech Zeitschr—Jan. 19, 26, 1905. No. 67952 each B.

Single-Phase.

Single-Phase Motors on Polyphase Systems. H. W. Doubrava. Discusses recent action in regard to the use of single-phase motors, the reasons for and against their use, the saving in cost, &c. 3200 w. Elec Rev, N. Y.—Feb. 18, 1905. No. 67820

See Street and Electric Railways.

Small Motors.

The Widening Use of Small Electric Motors. F. H. Kimball. An illustrated article referring specially to American practice. 1500 w. Cassier's Mag—Feb., 1905. Serial. 1st part. No. 67666 B.

Three-Phase.

The Gromo-Nembro Power-Plant Emile Guarini. Illustrated description of the three-phase 40,000-volt power-transmission from Gromo to Nembro (Lombardia), said to be the first plant of its kind in Europe. 2500 w. Cent Sta—Feb., 1905. No. 67716.

Variable Speed.

Variable Speed Motors. C. L. Sumpter. An illustrated article calling attention to characteristics of the direct current motors and their application. 1400 w. Elec Rev, Lond—Jan. 27, 1905. No. 67681 A.

TRANSMISSION.

Aluminium.

Aluminium. W. Smith. Read before the Birmingham Electric Club. Reviews the history of this metal and discusses its value as an electrical conductor, and other uses. Ills. 2500 w. Elec Engr, Lond—Jan. 27, 1905. No. 67679 A.

Insulation.

The Insulation of Armature or Other Coils for High Tension Apparatus. J. S. Highfield. An account of an investigation made of the breakdown of insulation, proving it to be due to the formation of nitric acid by brush discharge causing ozonization of the air. 1200 w. Elect'n, Lond—Jan. 27, 1905. No. 67683 A.

Power Transmission.

The Maximum Distance to Which Power Can Be Economically Transmitted. Discussions at New York and at Pittsburg of recent paper by Ralph D. Mershon. 10500 w. Am Inst of Elec Engrs—Feb., 1905. No. 68003 C.

Wire Stresses.

A Dynamometer for the Measurement of Stresses in Overhead Wires (Ein Dynamometer zur Messung der Drahtspannung in Freileitungen). George Nicolaus. The stress is measured by determining the force required to produce a certain lateral deflection. 1000 w. Elektrotech Zeitschr—Feb. 2, 1905. No. 67958 B.

INDUSTRIAL ECONOMY

Canada.

The Development of Canada. George W. Colles. A review of the history of Canada and the causes that have affected its development, giving much information of the resources and recent changes. 5000 w. Cassier's Mag—Feb., 1905. No. 67665 B.

China.

Mines and Railways in China. Comments on conditions in China, and the recent change of the control of mines and railways to the lately-created Board of Commerce. 1400 w. Aust Min Stand—Jan. 5, 1905. Serial. 1st part. No 67868 B.

Cost Keeping.

Cost Keeping on General Contract Work. A. W. Buel. Describing methods for use in outdoor and general construc tion work, showing their value in furnishing prompt and accurate information. 3500 w. Engineering Magazine—March, 1905. No. 67970 B.

Radiator Costs. R. W. M'Dowell. An example of foundry cost accounting, explaining the system. 2300 w. Foundry—Feb., 1905. No. 67592.

Education.

Desirable Entrance Requirements for Engineering Colleges. William Kent. Read before the Am. Assn. for the Adv. of Science. Information in regard to recent changes made, in the requirements for entrance, with opinions from several writers and other remarks. 2500 w. Eng News—Feb. 2, 1905. No. 67628.

Electrical Education in the French Universities (L'Enseignement Electrotechnique dans les Universités Françaises). C. Carmichel. A review of French educational methods in technology, with especial reference to electrical engineering. Serial. Part I. 3000 w. Revue Technique—Jan. 25 1905. No. 67924 D.

The Training of the Electrical Engineer. Dr. Louis Bell. A discussion of the qualities needed by a successful electrical engineer and the best means of acquiring them. 4400 w. Cassier's Mag—Jan., 1905. No. 67585 B.

Government Control.

Government Control of Railroad Earnings. L. F. Day. Discusses unwise legislation affecting railway rates, opposing the giving of the rate-making power to the Interstate Commerce Commission. 5000 w. Ry Age—Feb. 10, 1905. No. 67738.

Japan.

The Commerce and Mineral Industry of Japan (Le Japon: Son Commerce—Son Industrie Minière). Francis Marre. A tabulated review of Japanese commerce and metallurgical products. 1800 w. Revue Technique—Jan. 25, 1905. No. 67923 D.

Labor.

The Compensation of Labor. H. L. Gantt. A discussion of piece work, premium and bonus systems, showing that all wage systems are simply expedients to make employer and employee see the facts in the same light. 2800 w. Engineering Magazine—March, 1905. No. 67976 B.

The Employment and Preparation of Firemen. E. W. Pratt. Discusses mainly the personality and character of the men, method of hiring and educating the men, &c. General discussion. 17000 w. Pro W Ry Club—Jan. 17, 1905. No. 67722 C.

Mathematics.

Engineering Mathematics. E. Sherman Gould. Illustrates the part mathematics plays in developing engineering formula, claiming that it is the basis of all scientific engineering. 3000 w. Cassier's Mag —Jan., 1905. No. 67586 B.

Ownership.

Who Own the Railroads? H. T. Newcomb. Gives a memorandum of the results of a recent investigation which disproves the erroneous impression that railroad ownership is vested in a small group of the very rich. 2000 w. R R Gaz—Vol. XXXVIII, No. 8. No. 68024.

Patents.

Facts Concerning Patents Not Generally Understood, or of General Interest to Engineers. Frederick W. Winter. An explanation of the patent system in the United States and much information of interest. General discussion. 9500 w. Pro Engrs' Soc of W Penn—Jan., 1905. No. 67796 D.

Securities.

Electric Railway Securities as Investments. From a paper by Albert L. Kramer, in *The Annals of the American Academy of Political and Social Science.* Deals with companies in operation of city and interurban lines. 2400 w. R R Gaz —Vol. XXXVIII, No. 6. No. 67720.

MARINE AND NAVAL ENGINEERING

Battleships.

Some Vessels of the Russian Baltic Fleet. Engravings of seven of the vessels belonging to this fleet, noting their leading features, and giving brief descriptions 350 w. Engr, Lond—Jan. 20, 1905. No. 67542 A.

Car Ferry.

Car Ferry Detroit. Illustrated detailed description of an interesting vessel, especially with reference to the machinery. 2200 w. Marine Rev—Feb. 9, 1905. No. 67736.

Cruisers.

Armoured Cruisers. Discusses the construction of the "Edgard Quinet" as an example, giving a comparative table of types, and considers its value in warfare. 2200 w. Engr, Lond—Feb. 3, 1905. No. 67788 A.

Docks.

Floating Docks. Lyonel E. Clark. Abstract of a paper read before Inst. of Civ. Engrs., England. Describes types, and discusses the problems in design, the advantages and disadvantages, &c. 2000 w. Eng Rec—Feb. 25, 1905. No. 68041.

Fire Boat.

Fire Launch. Illustrated description of a powerful salvage vessel for service on the Manchester Ship Canal. 700 w. Engr, Lond—Feb. 10, 1905. No. 67883 A.

Ice Breakers.

Ice Breakers on Lower St. Lawrence. G. M. Fairchild, Jr. States the conditions on this river and gives information in regard to an ice-breaking service aiming to lengthen the season of navigation. Illustrated description of the ice-breaker "Montcalm." 2800 w. Marine Rev—Feb. 23. 1905. No. 68027.

Liners.

The Cunard Liner Caronia. An account of this new vessel, giving an idea of the arrangement and comfort made possible, and the features of special interest. 2000 w. Engr, Lond—Jan. 27, 1905. No. 67695 A.

The New Cunard Liners. Editorial discussion of the Caronia and Carmonia, and their machinery. Ills. 3000 w. Engng—Feb. 10, 1905. No. 67878 A.

Mercantile Marine.

The Making of the British Mercantile Marine. Brysson Cunningham. Information based on shipbuilding statistics of the last half-century, comparing the activity in England with other countries, and illustrating vessels, shipbuilding yards and appliances. 2500 w. Cassier's Mag—Jan., 1905. No. 67587 B.

Motor Boats.

A Gasoline Warship Launch. Illustrated description of an interesting Napier launch. 1200 w. Sci Am Sup—Feb. 11, 1905. No. 67715.

Internal-Combustion-Engine Launches. Illustrations and brief descriptions of boats of this class and their equipment. 1500 w. Engng—Feb. 3, 1905. No. 67784 A.

Motor-Boats at the Paris Automobile Show. An illustrated article describing characteristics of the exhibits. 2400 w. Engng—Jan. 27, 1905. No. 67689 A.

Successful Motor-Driven Canal Boat. Brief illustrated description of a boat propelled by a three cylinder gasoline engine of 21 h. p., which drives a 28-in. 3-bladed propeller. The design and construction of the hull and arrangement of the propeller are quite new. 500 w. Naut Gaz—Feb. 2, 1905. No. 67700.

Salvage.

The Salvage of Ships. Outlines briefly the history and administration of the Liverpool Salvage Assn., which has been in existence for 47 years, and describes the work carried out, illustrating the equipment. 3500 w. Engng—Jan. 20, 1905. Serial. 1st part. No. 67544 A.

Scouts.

The New Scouts for the King's Navy. Illustrated description of the "Sentinel," with report of the trials, and discussion of designs for this class of vessels. 2500 w. Engng—Feb. 3, 1905. No. 67785 A.

Shipbuilding.

Electric and Pneumatic Portable Tools in Shipbuilding. Frank C. Perkins. An illustrated article describing the operation of various tools. 800 w. Marine Engng —Feb., 1905. No. 67569 C.

Shipping.

Improvements in Shipping Ports. An illustrated description of recently completed improvements and those in progress in British ports. 3800 w. Ir & Coal Trds Rev—Jan. 27, 1905. Serial. 1st part. No. 67696 A.

Sidewheel.

The Sidewheel Steamship Old Dominion. Illustrated description of the last example of a type of ocean steamer which at one time predominated. 3300 w. Naut Gaz—Feb. 2, 1905. No. 67699.

Steering Gear.

Details of Electric Steering Gear of the Turbine Steamer "Manxman." Illustrated description of a combination of steam and electric steering gear fitted on board of this turbine-driven steamer. 1500 w. Engng—Feb. 17, 1905. No. 68053 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Beeston-Humber.

Two New Beeston-Humber Cars. Illustrated detailed descriptions of two new designs. 2000 w. Autocar—Feb. 11, 1905. No. 67867 A.

Belsize.

The Belsize—All British—Petrol Cars. Begins an illustrated detailed description of models of these cars. 1800 w. Auto Jour—Jan. 28, 1905. Serial. 1st part. No. 67672 A.

Brotherhood.

The 20-H. P. Brotherhood Petrol Car—Another New All-British Vehicle. An illustrated detailed description. 3000 w. Auto Jour—Feb. 4, 1905. Serial. 1st part. No. 67778 A.

Chenard-Walcker.

The 15 H. P. Chenard-Walcker Car. Illustrated description of a British car remarkable for silent running, simplicity of control, and flexibility of engine. 1000 w. Autocar—Jan. 21, 1905. No. 67529 A.

Delaunay-Belleville.

The Delaunay-Belleville Cars. Illustrates and describes interesting details of these cars. 1000 w. Autocar—Jan. 28, 1905. No. 67673 A.

Exhibition.

The Motor-Car Exhibition. An account of the third motor-car show promoted by the Society of Motor Manufacturers and Traders, held at Olympia, London. Describes many of the vehicles. Ills. 5000 w. Engng—Feb. 17, 1905. Serial. 1st part. No. 68052 A.

The Progress of Automobilism in 1904 (Les Progrès de l'Automobilisme en 1904). F. Drouin. Reviewing especially the developments of the year as shown in the exhibits at the recent Salon in Paris. Serial. Part I. 3000 w. Génie Civil—Jan. 28, 1905. No. 67914 D.

Gasoline Car.

The Heaviest Gasoline Propelled Vehicle in the World. Emile Guarini. Illustration and brief description of the gasolene electric motor coaches put in service on the North-Eastern Railway of England. 700 w. Ry & Loc Engng—Feb., 1905. No. 67583 C.

Industrial Vehicles.

The Latest Types of Industrial Motor Vehicles. Lucien Périssé. A review of Continental and British practice, with numerous illustrations of successful freight and passenger automobiles. 4500 w. Engineering Magazine—March, 1905. No. 67974 B.

Spring-Wheels.

Spring-Wheels for Motor Cars. Introductory remarks, and the commencement of an illustrated detailed description of the Halford spring-wheel is given in the present article. 3300 w. Auto Jour—Jan. 21, 1905. Serial. 1st part. No. 67530 A.

COMBUSTION MOTORS.

Gas Engines.

Gas Engine Economy. George Miller. Remarks on the effect on economy due to the position of the igniter. 1700 w. Mach, N. Y.—Feb., 1905. No. 67550 C.

Large Gas Engines (Ueber Gross-Gasmaschinen). Dr. Eugen Meyer. An address reviewing the development of the gas engine on the Continent, with illustrations of a number of engines of 1,000 h. p. and over. Two articles. 8000 w. 4 plates. Stahl u Eisen—Jan. 15, Feb. 1, 1905. No. 67932 each D.

The Internal Combustion Engine. J. R. Bibbins. Abstract of a paper read before the Modern Science Club, Brooklyn, N. Y. Discusses its principles and uses, new fields, performance, &c. Ills. 2200 w. Elec Rev, N. Y.—Feb. 4, 1905. No. 67624.

The Letombe Gas Engine System. Emile Guarini. Illustrates and describes the Letombe pressure gas producer and the system of regulation. 1500 w. Engr, U. S. A.—Feb. 15, 1905. No. 67838 C.

Ignition.

Ignition Troubles and Remedies. R. L. Hubler. Considers in detail the parts of a complete igniting outfit and the troubles that may arise, with the remedies. Especially referring to launch motors. 4800 w. Rudder—Feb., 1905. No. 67578 C.

Locomotives.

Application of the Gas Engine to the Locomotive and Steamship. A brief digest of a study of this problem by Peter Eyermann. 1000 w. Sci Am Sup—Feb. 4, 1905. No. 67662.

Gasoline Locomotives and Cars for Railroads. Illustrates and describes experimental vehicles on trial in England in the effort to solve the problem of economical operation of short lines. 2200 w. Sci Am Sup—Feb. 18, 1905. No. 67809.

Suction Gas.

The Pintsch Suction Gas Producer. S. F. Seager. Abstract of a paper read before the Mich. Engng. Soc. Illustrated detailed description of the present Pintsch suction gas plant and its operation. 2000 w. Eng News—Feb. 16, 1905. No. 67804.

HEATING AND COOLING.

Refrigeration.

Cold Storage at Scranton. Illustrated description of the Scranton Cold Storage and Warehouse Co.'s plant and its equipment. 1000 w. Ice & Refrig—Feb., 1905. No. 67651 C.

Steam Heating.

The Mechanical Plant of Simmons College, Boston. K. S. Howard. Brief description, with illustration showing the arrangement of the indirect heating apparatus. 1500 w. Eng Rec—Feb. 11, 1905. No. 67769.

Vacuum System.

Vacuum System of Heating. William Kavanagh. Detailed description of this system, with statement of its advantages. Ills. 2500 w. Engr. U. S. A.—Feb. 1, 1905. No. 67611 C.

Ventilation.

Air Purification in the Ventilating Plant of the City Hall, St. Louis. Concerning the operation of a water-spray filter for purifying the dirt-laden air. 1600 w. Eng Rec—Feb. 18, 1905. No. 67848.

The Science of Ventilation. J. D. Sutcliffe. Read before the Inst. of Heat. & Ven. Engrs., England. A comparison of the advantages and limits of natural and mechanical systems. Ills. 7500 w. Plumb & Dec—Feb. 1, 1905. No. 67776 A.

HYDRAULICS.

Air Lift.

Progress in the Applications of the Air-Lift Pump (Fortschritte im Bau von Mammut Pumpen). H. Steen. An illustrated description of recent installations of the "Mammut" system of air lift pumping for deep mine work in Germany. 3000 w. Glasers Annalen—Jan. 15, 1905. No. 67927 D.

Impulse Wheels.

The Governing of Impulse Wheels. Irving P. Church. Discussion suggested by a recent paper in *Engineering*, by Prof. Goodman upon the rise of pressure in a long pipe when the size of the jet is reduced to govern wheels of the Pelton type. 2000 w. Eng Rec—Feb. 25, 1905. No. 68039.

Pumping Engines.

Waterworks Pumping Engines in the United States and Canada. John Barr. Brief descriptions, with illustrations, of twelve stations visited, with general remarks. 4000 w. Inst of Mech Engrs—Jan. 20, 1905. No. 67572 D.

Stave Pipe.

Some Applications of Wooden Stave Pipe. John Birkinbine. Especially describes the construction of a line of wooden stave pipe six and one-half miles in length, along the Little Conemaugh River, near Johnstown, Penn., referring also to other work. Ills. Also discussion. 4200 w. Pro Engrs' Club of Phila—Jan., 1905. No. 68004 D.

Turbines.

The Classification of Turbines (Klassifikation von Turbinen). N. Baashuus. Deriving characteristic curves from which the turbine best adapted to the conditions of fall, speed, etc., may be determined. 1800 w. Zeitschr d Ver Deutscher Ing—Jan. 21, 1905. No. 67903 D.

MACHINE WORKS AND FOUNDRIES.

American Shops.

Some Impressions of American Workshops. A. J. Gimson. General impressions only. 1000 w. Inst of Mech Engrs—Jan. 20, 1905. No. 67571 D.

Arsenal.

The United States Arsenal at Rock Island. F. A. Stanley. Briefly outlines the history of the island and begins an illustrated description of the shops, their equipment, power plant, &c. 3500 w. Am Mach—Vol. 28, No. 5. No. 67599.

Chains.

Roller Chain Power Transmission and Construction of Sprockets. A. Eugene Michel. Information in regard to recent roller chains and the pitch line clearances of their sprockets. Ills. 2000 w. Mach, N. Y.—Feb., 1905. No. 67546 C.

Cores.

Core Sand Binders. J. S. Robeson. Read before the Pittsburgh Found. Assn. Setting forth the claims of gluetrin, discussing difference in sand structure, solid and liquid binders, &c. 4500 w. Ir Age—Feb. 9, 1905. No. 67702.

Cost Keeping.

See Industrial Economy.

Drying.

The Lochner Drying Apparatus (Das Lochnersche Trocknungsverfahren). O. Wedemeyer. Describing an apparatus for drying moulds by utilizing the heat from cooling castings. 1800 w. Stahl u Eisen—Jan. 15, 1905. No. 67935 D.

Electric Driving.

The Motor Equipment of Existing Machine Tools. George T. Hanchett. An illustrated article giving hints on selection of motors, connections, and cases of individual drive and geared connections. 2500 w. Am Elect'n—Feb., 1905. No. 67613.

See also Electrical Engineering, Motors.

Eye-Bars.

Comparisons of Full-Sized and Specimen Tests of Very Large Steel Eye-Bars. Gives a series of camparison tests made within the last few months, with remarks and conclusions. 800 w. Eng News—Feb. 2, 1905. No. 67631.

Flanging.

The Lovekin Pipe Flanging Machine. Illustrated description of the largest machine for expanding and flanging iron, steel, or other metal pipes into flanges of the lightest possible construction. 2500 w. Ir Age—Feb. 16, 1905. No. 67799.

Foundry.

Foundry of the Allis-Chalmers Co.,

Scranton, Pa. An illustrated description of changes made in remodeling an old plant, showing the improvements. 1000 w. Foundry—Feb., 1905. No. 67590.

Foundry Crane.

100-Ton Ladle Crane. Illustrates and describes a high powered overhead electric ladle crane built for the Ebbro Vale Steel Works. 1600 w. Engr, Lond—Feb. 10, 1905. No. 67881 A.

Grinding Wheels.

Emery Wheel "Dressers" and Grinding Wheel "Truing." Discusses points in the making of grinding wheels, and the necessity of using the diamond to make a perfect face. 900 w. Am Mach—Vol. 29. No. 5. No. 67600.

Iron Works.

American Iron Works (Amerikanische Eisenhütten). Max Kirdorf. A general description of American works and methods as observed by the writer during a recent tour. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 21, 1905. No. 67904 D.

Jigs.

Getting the Full Value Out of Jigs. J. F. Mirrielees. Suggestions for the use and care of jigs, outlining a working system. 1200 w. Mach, N. Y.—Feb., 1905. No. 67548 C.

Keys.

Key Design. Robert S. Riley. Discusses methods for proportioning keys in shafts. 1700 w. Am Mach—Vol. 28, No. 8. No. 68019.

Machine Tools.

Big Machine Tools. Joseph Horner. Discusses the leading problems and aspects of the big machine tools. Ills. 4000 w. Cassier's Mag—Jan., 1905. No. 67584 B.

Molding.

Molding a Sheave With Sweep and Cores. R. H. Palmer. Illustrates the appliances and describes the method. 600 w. Am Mach—Vol. 28, No. 7. No. 67801.

Molding in Cores. Vincent Colajezzi. An illustrated article giving examples showing that molds composed of dry sand cores can be constructed frequently cheaper and better than is possible with green sand molds. 1200 w. Foundry—Feb., 1905. No. 67593.

Patterns.

Pattern-Making Metals. H. Malone. in *Pattern Maker.* On the making and care of metal patterns. 2000 w. Mech Engr—Feb. 11, 1905. No. 67869 A.

Pattern Making. R. Watson. Abstract of paper read before the Rugby Engng. Soc. Suggestions of value, especially with regard to the protection of large patterns in the foundry. 4500 w. Elect'n, Lond—Feb. 10, 1905. No. 67876 A.

The Patternmaker from a Molder's Point of View. William S. McQuillam. Read before the N. Y. Found. Foremen's Assn. Discusses troubles with patterns, and the remedies for some of the defects. 1600 w. Foundry—Feb., 1905. No. 67594.

Planing Machines.

Some Features in the Design and Construction of American Planing Machines. Archibald Kenrick, Jun. Remarks are largely confined to the methods observed in a Cincinnati shop. 1500 w. Ills. Inst of Mech Engrs—Jan. 20, 1905. No. 67573 D.

Screw Cutting.

Thread Tools and Gages. A. Norman. The present article discusses hobs and chasers and their manufacture. Ills. 1500 w. Am Mach—Vol. 28, No. 6. Serial. 1st part. No. 67703.

Shop Organization.

Notes on Engineering Workshop Organization. R. Douglas T. Heap. Read before the Junior Engng. Soc., Swindon. States the leading requirements for the conduct of works, and illustrates by forms and cards for a stated purpose, explaining system. 2500 w. Engng—Feb. 17, 1905. Serial. 1st part. No. 68056 A.

Specialization.

Specialization in Manufacture. Alexander E. Outerbridge, Jr. Gives illustrations showing the advantage of quantity manufacture and undivided attention to a specialty. 1800 w. Am Gas Lgt Jour—Feb. 13, 1905. No. 67756.

Steel-Tired Wheels.

A Typical Shop Equipment for Handling Steel-Tired Wheels. Illustrates and describes the arrangement of equipment and facilities in a model wheel plant of the New York, New Haven & Hartford Railroad at Readville. 1500 w. St Ry Jour—Feb. 4, 1905. No. 67649 C.

Stores.

The Stores-Room Methods of the Pond Machine-Tool Works. H. L. Arnold. With numerous illustrations of the storekeeping departments of a large machine-shop, and copies of forms and records. 4000 w. Engineering Magazine—March, 1905. No. 67973 B.

MATERIALS OF CONSTRUCTION.

Alloys.

Some Hints on Metal Melting and Alloying. Walter J. May. Considers points which affect the condition of the metal, and the treatment necessary to secure sound castings. 2300 w. Prac Engr—Jan. 27, 1905. Serial. 1st part. No. 67675 A

Fire Brick.

The Manufacture of Refractory Materials (Ueber die Fabrikation Feuerfester Produkte). H. Huffinger. With plans and sections of a typical manufacturing plant, and description of the manufacture of fire brick, clay retorts, and refractory products generally. 1800 w. Glückauf—Feb. 4, 1905. No. 67944 D.

Fire-Clays.

The Fire-Clays of Missouri. H. A. Wheeler. Remarks on the importance of the clay industry in the United States, with information concerning the Missouri fire-clays. 5000 w. Am Inst of Min Engrs—Jan., 1905. No. 67577 C.

Fragility.

The Fremont Method of Determining the Fragility of Iron and Steel. Thorsten Y. Olsen. An explanation of the Fremont method and machine. Ills. 3800 w. Pro Engrs' Club of Phila—Jan., 1905. No. 68007 D.

Impact Tests.

Impact Tests in Detail. E. P. Buffet. Condensed translation of a paper by M. A. Pérot, describing an interesting investigation. Ills. 1000 w. Am Mach—Vol. 28, No. 8. No. 68018.

Muntz's Metal.

Mass Analysis of Muntz's Metal by Electrolysis. John G. A. Rhodin. From a paper before the Faraday Society. Describes a method devised for accurately determining the copper contents of Muntz's metal at a speed allowing the use of the results in the course of manufacture. Ills. 2500 w. Elect'n, Lond—Feb. 10, 1905. No. 67875 A.

Steel.

Steel as an Engineering Material. William Stuart Standiford. Considers steel as a material, its manufacture and the effect of different methods of treatment, the uses to which it has been applied, &c. 2000 w. Min Wld—Feb. 11, 1905. No. 67754.

The Influence of Carbon, Phosphorus, Manganese, and Sulphur upon the Strength of Open-Hearth Steel (Ueber den Einfluss von Kohlenstoff, Phosphor, Mangan, und Schwefel auf die Bruchfestigkeit des Martinstahls). A review of Campbell's formulas for determining the strength of steel from its composition. Serial. Part I. 4500 w. Stahl u Eisen—Jan. 15, 1905. No. 67934 D.

Stress Testing.

Alternating Stress Testing-Machine at the National Physical Laboratory. T. E. Stanton. An illustrated description of a machine recently fitted and erected in the workshop of the department. 4000 w. Engng—Feb. 17, 1905. No. 68051 A.

Thermit.

Aluminothermics. An illustrated article describing what thermit is, the applications made of it, and the things to be observed to secure success. 1600 w. Foundry—Feb., 1905. No. 67591.

MEASUREMENT.

Calorimeter.

The Junker Gas Calorimeter in Practice. Carl F. Dietz. Describes the apparatus for determining the calorific value of gases and a test made with it. Discussing the results, adaptability, &c. Ills. 3000 w. Stevens Ind—Jan., 1905. No. 67726 D.

High Temperatures.

On the Measuring of High Temperatures in Connection with Metallurgical Work. Dr. Alfred Gradenwitz. Considers some of the fields of application of pyrometers. Ills. 1200 w. Min Rept—Feb. 9, 1905. No. 67757.

Thermometers and Pyrometers, with Some of Their Industrial Applications. Robert S. Whipple. Read before the Cleveland Inst. of Engrs. Gives a summary of the various means of measuring temperature in general use, and discusses details and applications. 5000 w. Engng—Feb. 17, 1903. No. 68055 A.

Pendulum.

An Electric Pendulum with Free Escapement (Pendule Electrique à Echappement Libre). Ch. Féry. The solenoid action of the magnet pendulum-bob is regulated by the pendulum itself, which also acts as a motor to drive the escapement wheel. 800 w. Comptes Rendus—Jan. 23, 1905. No. 67921 D.

Speedometer.

The Krauss Speedometer. Illustrated description of a tachometer especially designed for automobiles. 1500 w. Sci Am Sup—Feb. 18, 1905. No. 67811.

POWER AND TRANSMISSION.

Compressed Air.

Experiments with High-Speed Compressors (Versuche mit Raschlaufenden Kompressoren). A. Lebrecht. Data and results of tests upon balanced compressors adapted for direct connection to electric motors, and operating at rotative speeds of 800 to 1,200 revolutions per minute. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 4, 1905. No. 67908 D.

The Central Compressed-Air Power Plant of the St. Louis Terminal Station. A description of the extensive Ingersoll-Sergeant plant used for the signal system, for charging brake reservoirs, and for general power purposes at the Union Terminal at St. Louis. 2000 w. Compressed Air—Feb., 1905. No. 67977.

Valve Gears of Compressed-Air Rock Drills. C. Weidmann, in *Glückauf*. An illustrated study of the action of valve gears in rock drills. 2000 w. Quarry—Feb., 1905. No. 67775 A.

Conveyors.

Improved Conveyor Systems and Appliances (Neuere Konveyor-Systeme und Anlagen). M. Buhle. Illustrating and describing the coal conveying systems of Hunt, of Bradley, and others as used in Germany. 1800 w. 1 plate. Glückauf—Feb. 11, 1905. No. 67945 D.

Improved Pipe and Mixer System for Water Conveyors (Neue Konstruktionen für die Anlage von Rohrleitungen und Mischtrichtern beim Spülversatzverfahren). Details of pipes, connections, hoppers, etc., for use in conveying ashes and débris by water. 1200 w. Glückauf—Feb. 11, 1905. No. 67946 D.

The Waste Conveying Plant of the Schedewitz Coal Company at Zwickau, in Saxony (Das Spülversatzverfahren beim Erzgebirgischen Steinkohlen-Aktienverein in Schedewitz bei Zwickau in Sachsen). H. Jobst. Illustrating and describing the use of conveyor bands and water jets for carrying débris, ashes, etc. Two articles. 6000 w. Glückauf—Jan. 28, Feb. 4, 1905. No. 67942 each D.

Cranes.

A Gigantic Electric Shipyard Crane. Dr. Alfred Gradenwitz. Illustration of the powerful electric crane recently erected at Lloyd's arsenal in Trieste, with description. 900 w. Sci Am Sup—Feb. 11, 1905. No. 67714.

Notes on Cranes—The Wellman Furnace Charging Machine. A. D. Williams. Illustrates and describes types of Wellman machines. 800 w. Am Mach—Vol. 28, No. 5. No. 67601.

Special Forms of Cranes. Joseph Horner. Illustrates and describes recent types for special demands. 3000 w. Cassier's Mag—Feb., 1905. Serial. 1st part. No. 67668 B.

Recent Cranes (Neuere Krane). A. Müller. Illustrating and describing some recent, electrically-driven travelling cranes for machine shops and iron works. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 11, 1905. No. 67911 D.

See also Civil Engineering, Waterways and Harbors.

Gear Teeth.

The Strength of Gear Teeth Sustaining Shock. Gives tables showing values of safe tooth loads calculated from the original Lewis formula, and also from the reduced Lewis formula. 2000 w. Am Mach—Vol. 28, No. 7. No. 67802.

Tooth Form and Velocity Ratio in Gear Wheels (Genauigkeitsgrad und Geschwindigkeitsverhältnis bei Verzahnungen). W. Hartmann. Showing the advantage of the involute form of tooth, and demonstrating the variation in velocity-ratio produced by a change in the form of curve. 2000 w. Zeitschr d Ver Deutscher Ing—Feb. 4, 1905. No. 67909 D.

STEAM ENGINEERING.

Boiler Explosion.

Boiler Explosion on the New York Central. George L. Fowler. An illustrated account of an explosion which derailed and wrecked another passing train. 2000 w. R R Gaz—Vol. XXXVIII, No. 7. No. 67833.

Boiler Inspection.

New Official Requirements for Steam-Boiler Installation (Neue Allgemeine Polizeiliche Bestimmungen über die Anlegung von Dampfkesseln). C. Bach. A review of boiler explosions in Germany, and a discussion of the new regulations framed by a commission of engineers. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 28, 1905. No. 67905 D.

Boilers.

A Comparison of Vertical and Horizontal Tubes in Water-Tube Boilers. W. R. Cummins. Reviews the conditions necessary to make a commercially successful boiler, favoring the vertical tube. Discussion. 16 plates. 10000 w. Trans N-E Coast Inst of Engrs & Shipbuilders—Jan., 1905. No. 67825 E.

Circulation of Water in Steam Boilers. Egbert P. Watson. Considers the evils of poor circulation; the natural, artificial and forced circulation, &c. 2500 w. Cassier's Mag—Jan., 1905. No. 67588 B.

Central Stations.

A Study for a Central Power and Heating Plant at Washington. Extracts from the interesting report of Bernard R. Green, assisted by Prof. S. Homer Woodbridge, in regard to the investigations made to determine the advisability of erecting a station for the group of Federal executive buildings in the vicinity of the Mall. 5400 w. Eng Rec—Feb. 11, 1905. No. 67772.

Economies Obtainable by Various Uses of Steam in a Combined Power and Heating Plant. A discussion of economies obtainable at the isolated plant in Washington, reported by B. R. Green and S. Homer Woodbridge. Critical review. 4000 w. Eng Rec—Feb. 18, 1905. No. 67852.

Combustion.

Combustion. C. C. Major. Analytical study of the chemical and thermal changes in the combustion of fuels, deriving formulas for the computation of the mechanical energy evolved. 5500 w. Power—Feb., 1905. No. 67564 C.

Engine Economy.

The Best Economy of the Piston Steam Engine at the Advent of the Steam Turbine. Prof. J. E. Denton. Read before the Mech. Sec. of the Int. Cong. of Arts and Sciences. Traces the development of economy in marine and stationary engines, comparing the economy of the piston engine and the steam turbine, &c. 5500 w. Eng Rec—Feb. 25, 1905. No. 68037.

Engines.

A Large Rolling Mill Engine. Illustrated description of an engine in use at the great Hungarian State Steel Works of Diósgyör, near Miskole. 500 w. Engr, Lond—Feb. 3, 1905. No. 67789 A.

Engines at the Power Stations, and at the St. Louis Exhibition. Alfred Saxon. Notes on two of the large power stations in New York, and on the engines exhibited at St. Louis. Ills. 2000 w. Inst of Mech Engrs—Jan. 20, 1905. No. 67574 D.

Expansion Joints.

Compensating Pipe Connections (Kompensationsrohre). H. Still. Describing various forms of connections to provide for the expansion and contraction of long lines of pipe. 1800 w. Glückauf—Jan. 14, 1905. No. 67939 D.

Feed Water Heaters.

Location of Feed-Water Heaters and Feed Pipes. W. H. Wakeman. Describes arrangements of piping for feed-water heaters, giving diagrams. 1300 w. Engr, U. S. A.—Feb. 15, 1905. No. 67837 C.

Fuel Economy.

Fuel Economy in Steam Power Plants. William H. Booth and John B. C. Kershaw. Considers the analysis and treatment of feed-water, the sampling and testing of fuel, air supply, types of boilers and furnaces, steam superheating and condensation, waste gases, draught, &c. Ills. 12800 w. Inst of Elec Engrs (England)—Jan. 12, 1905. No. 67686 D.

Indicating.

Indicating Westinghouse Engines. H. L. Strong. Describes method. 1500 w. Power—Feb., 1905. No. 67567 C.

Indicator Connections. J. W. Parker. Explains some arrangements tried, and the results. Ills. 800 w. Power—Feb., 1905. No. 67565 C.

The Application of the Indicator to Rotary Engines. W. Pollard Digby. Describes the circumstances under which indicator cards were taken on certain rotary engines, and what they show. 2500 w. Engr, Lond—Jan. 27, 1905. No. 67691 A.

Manholes.

Boiler Manholes and Handholes. R. T Strohm. Considers the location, size, reinforcing rings, covers, &c. Ills. 2000 w. Am Elect'n—Feb., 1905. No. 67612.

Oil.

Oil as a Fuel. Describes methods of burning, especially the injectors for breaking up the stream of oil, setting forth the claims of the Lucal system. 2200 w. Ir & Coal Trds Rev—Jan. 27, 1905. No. 67698 A.

Power Plant.

The Steam-Power Plant of the Hanover Electric Station (Die Dampfmaschinenanlage des Drehstromwerkes der Stadt Hannover). Gustav ter Meer. With plan of the engine room, details of the machinery, and data and results of tests of engines and boilers. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 21, 1905. No. 67901 D.

Reheaters.

On the Economy of Reheaters. Ernest R. Briggs. An examination of the principal reheater cycles in use on various engines. 2500 w. Engr, Lond—Feb. 10, 1905. No. 67880 A.

Steam Turbines.

A Comparison of Steam Turbines. R. M. Neilson. Read before the Manchester Assn. of Engrs. An illustrated article explaining the working of the various types of turbines for the purpose of comparison. 3800 w. Mech Engr—Jan. 21, 1905. Serial. 1st part. No. 67539 A.

Low-Pressure Steam Turbines for Mine Purposes. George E. Walsh. Describes an improved type of low-pressure steam turbine, and its application to mining operations. 2200 w. Min Wld—Jan. 28, 1905. No. 67545.

Making a Small Curtis Turbine. H. J Travis. Drawings and description of constructional details, discussing operative results, losses, bucket speeds, power available, and economy. 3700 w. Power—Feb., 1905. No. 67566 C.

Notes on Steam Turbines. Frederick C. Bates. Read at meeting of the Engine Builders' Assn. Briefly reviews the history of the turbine, explaining the principle and describing modern types. 2200 w. Ir Trd Rev—Feb. 23, 1905. No. 68012.

Power Required for Condensing Auxiliaries in a Steam Turbine Plant. J. R. Bibbins. Gives results of tests made, describing methods of observation and calculation. 2200 w. Power—Feb., 1905. No. 67568 C.

The Hamilton-Holzwarth Steam Turbine (Die Hamilton-Holzwarth Dampfturbine). A. Bantlin. A full detailed description of the Holzwarth steam turbine. as built at Hamilton, Ohio, and exhibited at St. Louis. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 28, 1905. No. 67906 D.

The Lindmark Steam Turbine. An illustrated explanation of the features of this turbine as given in the patent records, explaining the purpose of the invention, its action, &c. 1300 w. Mach, N. Y.—Feb., 1905. No. 67549 C.

The Steam Turbine. F. G. Gasche. Abstract of a paper presented before the Steel Works Club of Joliet, Ill. A review of the development of types of turbines. and remarks on the advantages over the reciprocating engine. Ills. 2500 w. Engr, U. S. A.—Feb. 15, 1905. No. 67839 C.

Superheating.

Efficiency Tests of the Wolf Superheated Steam Portable Engine (Leistungsversuche an Wolfschen Heissdampf-Locomobilen). M. F. Gutermuth. Data and results of tests with superheating up to 140° C., showing a result of 9¼ pounds of steam per horse-power hour. 4000 w. Zeitschr d Ver Deutscher Ing—Feb. 11, 1905. No. 67910 D.

The Specific Heat of Superheated Steam. The present article reviews the paper of Prof. Sidney A. Reeve, which was published in the Worcester Polytechnic Journal. 2500 w. Engr, Lond—Feb. 3, 1905. Serial. 1st part. No. 67787 A.

The Superheating of Steam and Its Influence on Engine Economy. R. Neilson. The first of two articles; including a description of the various modes of giving additional heat to the steam, with typical forms of superheater construction. 4000 w. Engineering Magazine—March, 1905. No. 67972 B.

Tests.

Test of the Power Plant of the Cambridge Electric Light Company. Lionel S. Marks. Gives results of tests made for determining whether the guarantees of the steam engine builders were fulfilled. Ills. 3500 w. Harvard Engng Jour—Jan., 1905. No. 67597 C.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Anthracite Situation in Colorado. A. Lakes. Information in regard to the location, occurrences and quality. 1200 w. Min Rept—Jan. 26, 1905. No. 67551.

Virginia Anthracite Coal. L. S. Randolph. Information concerning these deposits. the character of the coal, recent development, &c. Ills. 3300 w. Cassier's Mag—Feb., 1905. No. 67669 B.

Belgium.

Black Band Deposits in the Campine Coalfield. B. Schulz-Briesen. Concerning the deposits of black band iron ore in association with the coal, and the indication of a co-relation between this Belgian field and those of Dudley and Cleveland in England. Map. 1200 w. Ir & Coal Trds Rev—Jan. 27, 1905. No. 67697 A.

Borings in the Coal and Iron Districts of Northern Belgium (Bohraufschlüsse von Kohlen und Blackband Lagerstätten im Nordbelgischen Kohlenbecken der Campine). B. Schulz-Briesen. With sections of the strata, and map showing the relation of the deposits to those of England and Germany. 2500 w. Glückauf—Jan. 14, 1905. No. 67937 D.

Canada.

The Blairmore-Frank Coal Field. Alberta, Canada. E. Jacobs. A description of a comparatively new coal field that is being rapidly opened. Ills. 4000 w. Mines & Min—Feb., 1905. No. 67639 C.

Carboniferous Flora.

Carboniferous Flora of Britain. John Pringle. Read before the N. Wales branch of the Nat. Assn. of Colliery Engrs. Reviews the geology of Britain and gives information of interest concerning the coal plants. 5500 w. Aust Min Stand—Dec. 29. 1904. No. 67815 B.

Coal Boring.

Pneumatic Coal-Boring Machines and Tools. W. Lynch. Read before the S. Staffordshire and E. Worcestershire Inst. of Min. Engrs. (Abstract.) Briefly describes some of the tools and their operations. General discussion follows. Ill. 2500 w. Col Guard—Feb. 17, 1905. No. 68050 A.

Coal Cutting.

Tests of a Coal Cutting Machine (Versuche mit einer Schrämmaschine mit Drehendem Schrämwerkzeug). Giving the time required to cut various areas, with a revolving spindle cutter driven by compressed air motor. 800 w. Glückauf —Jan. 28, 1905. No. 67943 D.

Coal Supplies.

Final Report of the Royal Commission on Coal Supplies, 1905. 13500 w. Col Guard—Jan. 27, 1905. (Supplement.) No. 67687 A.

Coal Testing.

The Fuel-Testing Plant at St. Louis. From a recent report of the U. S. Geol. Survey. A description of this exhibit, describing the plant and tests made, and giving related information. 5400 w. Ir Trd Rev—Feb. 16, 1905. No. 67816.

Coke.

By-Product Coke as Made by the Coke Oven Plant of the Otto-Hoffman and United-Otto Types, Camden, N. J. Edwin A. Moore. Read before the Philadelphia Found. Assn. Describes the method of manufacturing coke and the recovery of the by-products from the coal by means of the Otto-Hoffman system. 8700 w. Ir Trd Rev—Feb. 9, 1905. No. 67739.

Lamp-Black Oil Coke. Robert Schorr. Gives information in regard to the use made of lamp-black by the California Gas & Electric Corporation, at Oakland. 900 w. Eng & Min Jour—Feb. 16, 1905. No. 67821.

Coke Ovens.

The Collin Coke Oven (Koksöfen Bauart Collin). Fr. Frölich. Giving sectional details of continuous ovens arranged for recovery of by-products, either with or without regenerators. 2000 w. Zeitschr d Ver Deutscher Ing—Jan. 21, 1905. No. 67902 D.

Colorado.

The Geology and Coal Deposits of the Spanish Peaks' District. A. Lakes. Illustrated description of these Southern coal fields of Colorado. 1500 w. Min Rept—Feb. 16, 1905. No. 67854.

Deep Mines.

Problems of Thick Coal Workings in Deep Mines. Lawrence Holland. Read before the S. Staffordshire & E. Worcestershire Inst. of Min. Engrs. Describes conditions in mines 3,483 ft. in depth, offering suggestions for working. General discussion follows. 4000 w. Col Guard —Jan. 27, 1905. No. 67688 A.

Missouri.

The Coal-Fields of Missouri. B. F. Bush. A description of these fields, with map, an account of the methods of mining and character of the coals. 4800 w. Am Inst of Min Engrs—Jan., 1905. No. 67604.

Peat.

New Method of Treating Peat. A brief description of the Stauber method. 1000 w. Sci Am Sup—Feb. 18, 1905: No. 67810.

The Peat Industry. Arthur P. Hall and Richard C. Tolman. Describes briefly the methods of preparing peat for market, and states what has been accomplished in other countries. 1600 w. Eng & Min Jour—Feb. 9, 1905. No. 67745.

Tipples.

Coal Mine Tipples. H. G. Tyrrell. Illustrates and describes two designs of steel coal tipples such as are generally used in West Virginia. 500 w. Eng & Min Jour—Feb. 2, 1905. No. 67608.

Waste Heat.

The Utilization of Waste Heat from Coke Ovens. Considers the heat available and methods and apparatus best suited for using it for the generation of steam. 2500 w. Mines & Min—Feb., 1905. No. 67636 C.

COPPER.

Butte.

The Butte Copper Interests. Dwight E. Woodbridge. A description of the district's mines and smelters. Ills. 3500 w. Ir Age—Feb. 16, 1905. No. 67800.

Spain.

Rio Tinto. J. W. Gregory. Abstract from proceedings of the Australasian Inst. of Min. Engrs. An illustrated article describing the geology and ores. The chief types of ore are the copper-bearing iron pyrite, and cupriferous schist. The ore contains 20 to 25 dwt. of silver per ton and a trace of gold. 1600 w. Eng & Min Jour—Feb. 23, 1905. No. 68022.

South Africa.

The Copper Districts of Cape Colony, South Africa. Walter Harvey Weed. Map and description of the copper-producing district, the ore, occurrence, &c. 1000 w. Eng & Min Jour—Feb. 9, 1905. No. 67746.

GOLD AND SILVER.

Assaying.

Crude Oil for Fire Assaying. F. C Bowman. Abstract of a paper read before the Colorado Sci. Soc. An account of experiments with crude oil, and the cost. 600 w. Eng & Min Jour—Feb. 2, 1905. No. 67606.

Australia.

Castlemaine Goldfield. E. J. Dunn. Report of recent investigations of this field. 1600 w. Aust Min Stand—Dec. 22, 1904. No. 67540 B.

Comstock.

Unwatering the Comstock Lode. An account of the numerous efforts made to unwater and explore the entire Comstock lode, the degree of success, and an illustration of the electric pumps recently installed. 3200 w. Min & Sci Pr—Feb. 4, 1905. No. 67760.

Cripple Creek.

The Mines of Cripple Creek, Colo. Information from the recently issued bulletin No. 254, by Lindgren and Ransome of the U. S. Geol. Survey. 2800 w. Min & Sci Pr—Jan. 21, 1905. Serial. 1st part. No. 67557.

Cyanide.

Filling and Emptying Cyanide Vats by Machinery. An illustrated description of the Blaisdell automatic tank emptying system as installed in South Africa. 800 w. Min Rept—Feb. 2, 1905. No. 67640.

Some Further Improvements in Appliances for the Cyanide Clean-Up. D. V. Burnett. Describes the process as adopted at the present time on the Crown Deep, Ltd. Ills. 1500 w. Jour Chem, Met, & Min Soc of S Africa—Dec., 1904. No. 67671 E.

The Use of Mercury Chloride in Testing Cyanide Solutions. Leonard M. Green. A report of investigations of the reactions of mercuric chloride on copper double cyanides and, incidentally, on zinc double cyanides. 1000 w. Min & Sci Pr —Jan. 28, 1905. No. 67642.

Mexico.

The Gold-Mines of the San Pedro District, Cerro de San Pedro, State of San Luis Potosi, Mexico. George A. Laird. Briefly reviews the history of the district, describing the geology, ores, mines, methods of mining, source and distribution of the ores. Map. 7200 w. Am Inst of Min Engrs—Jan., 1905. No. 67575 D.

Nevada.

The Goldfields District, Nevada. A description of this district, as given by J. E. Spurr of the U. S. Geol. Survey. 2000 w. Sci Am Sup—Feb. 18, 1905. No. 67812.

Tonopah and Goldfield, and Their Rapid Development. An illustrated account of these new mining districts of Southern Nevada. 1500 w. Min & Sci Pr—Feb. 11, 1905. No. 67858.

New Zealand.

The Hauraki Goldfields, New Zealand. Waldemar Lindgren. An illustrated account of this interesting gold-mining region and its development. 2500 w. Eng & Min Jour—Feb. 2, 1905. No. 67605.

Placer Gold.

Source of the Placer Gold in Alder Gulch, Montana. Earl Douglass. Explains evidences that indicate that it was from adjacent lodes. 3500 w. Mines & Min—Feb., 1905. No. 67638 C.

Rhodesia.

Gold Mining in Rhodesia. F. C. Roberts. The present number gives an illustrated description of the country, its geology and ancient workings. 1200 w. Min & Sci Pr—Feb. 4, 1905. Serial. 1st part. No. 67759.

Smelting.

Chloro-Electrolytic Smelting. Abstract of a paper by Prof. W. Morley Cobeldick, read before the Chemical Society of London, which discussed the application of the Swinburne-Ashcroft process to the treatment of Broken Hill ore. 4000 w. Elec-Chem & Met Ind—Feb., 1905. No. 67621 C.

Spain.

Gold Mining in the Ancient Roman Workings in Spain. Alexander Del Mar. An account of the placers of Las Medulas describing the manner in which the ancients used advanced methods of hydraulic engineering in gold mining. 4000 w. Engineering Magazine—March, 1905. No. 67975 B.

Telluride Ores.

The Existence of Telluride Ores in the Hauraki Goldfields. Notes on the metallurgical practice and costs of treatment of ores and sands at Kalgoorlie. 1300 w. N Z Mines Rec—Dec. 16, 1904. No. 67527 B.

Transvaal.

The Transvaal Mining Industry in 1904. A report of a very successful year. 3000 w. Engr, Lond—Feb. 3, 1905. No. 67790 A.

Washing.

The Washing of Goldbearing Gravel in Sluices (Die Verwaschung Goldhaltiger Gerölle in Gerinne). L. St. Ranier. A discussion of the influence of the size of pebbles and the velocity of the water flow upon the separation of the gold. Two articles. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 4, 11, 1905. No. 67950 each D.

IRON AND STEEL.

Alabama.

Iron Mining in the Birmingham District, Alabama. W. R. Crane. An illustrated article describing the deposits, methods of mining, ore handling, haulage, &c. 3300 w. Eng & Min Jour—Feb. 9, 1905. No. 67747.

Blast Furnaces.

Fundamental Principles Involved in Blast Furnace Practice. Edward A. Uehling. Considers the raw materials used, the preparation of the ores, fuel, charging, &c. 9500 w. Jour Fr Inst—Feb., 1905. No. 67724 D.

Colorado.

Colorado Iron Ore Deposits. James Angus Snedaker. On the iron ore resources of this State, suitable for steel manufacturing. 1000 w. Eng & Min Jour—Feb. 16, 1905. No. 67818.

Dry Blast.

Is it Advantageous to Dry the Air for Blast Furnaces? (Ist es Vorteilhaft den Hochöfengebläsewind zu Trocknen?) Bernhard Osann. An examination of the Gayley dry-air blast system, maintaining that the possible gain is overbalanced by the additional cost. 5000 w. Stahl u Eisen—Jan. 15, 1905. No. 67933 D.

The Application of the Dry-Air Process to Blast Furnaces (Die Verwendung von Trockenem Gebläsewind in Hochofenbetriebe). An account of the Gayley dry-air blast system emphasizing the advantages of independence of meteorological conditions and changes. 1200 w. Oesterr Zeitsch f Berg u Hüttenwesen—Jan. 21, 1905. No. 67948 D.

The Gayley Dry Air Blast. Brief reports of some of the theories advanced to account for the facts givin in paper by James Gayley. 2500 w. Ir Age—Feb. 9, 1905. No. 67701.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Iron District.

Animikie, or Loon Lake, Iron-Bearing District. W. N. Smith. Information concerning recent work in this district of Ontario. Map. 3500 w. Min Wld—Feb. 18, 1905. No. 67857.

Manganese.

Sulphides and Silicates of Manganese in Steel. J. E. Stead. A detailed description of experimental investigations. Ills. 2200 w. Ir & St Mag—Feb., 1905. No. 67721 D.

Solidification.

The Increase in Volume of Liquid Iron, Saturated with Carbon in the Electric Furnace, at the Moment of Solidification (Sur l'Augmentation de Volume de la Fonte Liquide, Saturée de Carbone au Four Electrique au Moment de la Solidification). Henri Moissan. Data and results in connection with the artificial production of diamonds, showing that iron of small carbon content contracts, and with large carbon content expands, on solidification. 2500 w. Comptes Rendus—Jan. 23, 1905. No. 67918 D.

MINING.

Conveyors.

See Mechanical Engineering, Power and Transmission.

Cost.

The Cost of Mining. W. R. Ingalls. A general consideration of the comparative cost of mining, stating the conditions which determine the results. 2600 w. Eng & Min Jour—Feb. 16, 1905. No. 67820.

Deep Leads.

The Deep Leads of Victoria. Waldemar Lindgren. An illustrated description of the conditions, and of the methods of mining. 2200 w. Eng & Min Jour—Feb. 16, 1905. No. 67819.

Electric Blasting.

Many Advantages of Blasting by Electricity. George A. Allen. An illustrated article explaining the usual way of arranging the blast and connecting the wires, and giving information in regard to fuses, the blasting machine, &c. 3800 w. Min Wld—Feb. 11, 1905. No. 67753.

Electric Power.

A Model Electric Mining Plant. H. A. Pharo. Illustrates and describes an electric plant for driving mining and milling machinery near Silver City, Idaho. The first high-tension transmission built in America by a mining company for its own use. 3000 w. Cassier's Mag—Feb., 1905. No. 67664 B.

Application of Electric Power in Collieries. G. M. Brown. Abstract of a paper read before the Rugby Engng. Soc. Considers the use of electricity in the form of direct current, and also alternating current, the applications, &c. 4000 w. Ir & Coal Trds Rev—Feb. 3, 1905. No. 67792 A.

Dangers Attending the Employment of Electricity in Mines. Abstract from *Glückauf.* An illustrated article discussing the conditions which add to the dangers of the employment of electricity, the safety devices and precautions to be used, &c. 2300 w. Ir & Coal Trds Rev—Feb. 10, 1905. No. 67884 A.

Electricity in Coal Mining. George E. Walsh. Considers the applications thus far made of electricity in the mining of coal. 1800 w. Eng & Min Jour—Feb. 2, 1905. No. 67609.

High-Tension Systems for Mining Purposes. George E. Walsh. An account of the application of electric power at Folsom Creek, Cal., and neighboring mining regions. 1400 w. Eng & Min Jour—Feb. 23, 1905. No. 68021.

Explosions.

Coal-Dust Explosions in Mines. W. H. Graves. Discusses the conditions under which they have occurred and the methods for their prevention. 3000 w. Mines & Min—Feb., 1905. No. 67637 C.

Gravel Mining.

Gravel-Mining Costs in Alaska and Northwest Canada. Chester W. Purington. Gives facts compiled from statistics collected during a recent inspection of the placer fields in Alaska, Yukon Territory, and northern British Columbia. 1600 w. Eng & Min Jour—Feb. 9, 1905. No. 67744.

Hoisting.

Hoists and Hoisting. Dennis H. Stovall. Illustrates four types of hoists, and explains the work for which they are united. 800 w. Min Rept—Feb. 2, 1905. No. 67641.

Underground Hoisting in Deep Level Mines. G. A. Denny. Describes briefly a scheme of utilizing conveyor belts for this purpose on inclines of an angle of 20 to 23 degrees. Also discussion. 11000 w. Jour S Af Assn of Engrs—Oct., 1904. No. 68026 F.

Mine Equipment.

Some Applications of Electricity in German Mines. Illustrated description of a number of installations of pumping and winding plants. 2500 w. Elect'n, Lond —Jan. 27, 1905. No. 67685 A.

Vesta No. 4 Mine of the Vesta Coal Co. at California, Pa. William L. Affelder. An illustrated detailed description of one of the finest equipped coal mines in the United States. 6500 w. Mines & Min—Feb., 1905. No. 67634 C.

Mine Fire.

The Mine Fire at Dominion No. 1 Colliery, Glace Bay, N. S. Shirley Davidson and Norman McKenzie. A description of the mine and the disaster, with illustrations and plates. 5400 w. Can Soc of Civ Engrs—Jan., 1905. No. 68000 D.

Mine Gas.

Gases in Mines. W. Poole. Lecture delivered at Charters Towers School of Arts. Considers the gases which poison the air for breathing purpose, and the necessity for efficient ventilation through the working places of mines. 3500 w. Queens Gov Min Jour—Dec. 15, 1904. No. 67595 B.

Mining Laws.

United States Mining Laws. C. W. Goodale. Abstract of a paper read before the Montana Soc. of Engrs. Gives opinions of various men of experience, and reviews briefly some of the conditions in laws of other countries, with an account of the copper trust location. 2800 w. Eng & Min Jour—Feb. 2, 1905. No. 67607.

Mining Power.

A Discussion of Systems of Power Supply for Mine Operation. F. V. Henshaw. Comparing the relative advantages of electricity and compressed air for mining work. 3000 w. Engineering Magazine—March, 1905. No. 67971 B.

Ore Handling.

Coal and Ore Handling Plant in the Island of Elba. Illustrates and describes a system of automatically-operated overhead conveyors for the blast-furnace plant at Portoferraio, to handle the ore and coal. 1600 w. Sci Am Sup—Feb. 4, 1905. No. 67661.

Ore Handling at Conneaut, Ohio. H. E. Scott. Brief illustrated description of the main features of this harbor and the system for rapidly and economically handling the ore. 3800 w. Jour Worcester Poly Inst—Jan., 1905. No. 67570 C.

Ore Treatment.

Ore Treatment in Laurium, Greece. Henry F. Collins. Brief description of the methods of a French company and a Greek company engaged in smelting the output of the ancient mines. 2000 w. Eng & Min Jour—Feb. 23, 1905. No. 68020.

Pumping.

Electric Pumping Plants. Frank C. Perkins. Illustrated description of a number of electrically driven pumping plants in Germany, England, and America. 3500 w. Mines & Min—Feb., 1905. No. 67635 C.

Records.

The Method of Keeping "Stope Books" in the Mines of the Butte District, Montana. Charles E. Morrison. An explanation, with diagrams. 2000 w. Sch of Mines Qr—Jan., 1905. No. 68011 D.

Shaft Sinking.

The Deepening of a Double Shaft at the Königsgrube Mine at Röhlinghausen in Westphalia (Das Abteufen eines Doppelschachtes der Zeche Königsgrube bei Röhlingshausen i. W.). H. Bonacker. Describing a difficult piece of shaft sinking through quicksand. 1200 w. Glückauf—Jan. 14 1905. No. 67938 D.

Tubbing.

The Question of Corrugated Tubbings (Zur Frage der Gewellten Tubbings). Prof. Heise. A discussion of the advantages of corrugated sectional linings for shafts. 2000 w. Glückauf—Jan. 21, 1905. No. 67940 D.

Underground Temperature.

Notes on Underground Temperature Observations. James Stirling. Gives the chief results of a series of observations made in some of the deep mines at Bendigo, to a depth of 3,250 ft. 1500 w. N Z Mines Rec—Dec. 16, 1904. No. 67528 B.

Winding Ropes.

Nickel-Steel Winding Ropes (Förderseildraht aus Nickelstahl). Julius Divis. A comparison of nickel steel with carbon steel for ropes for mine hoists, showing that the gain due to the superiority of the nickel steel is more than offset by the higher price. Two articles. 5000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 28, Feb. 4, 1905. No. 67949 each D.

MISCELLANY.

Petroleum.

Petroleum in the Malay Islands (Das Erdöl auf den Malaiischen Inseln). Hans Höfer. A detailed account of the petroleum developments in the Dutch East Indies and in the Philippine Islands. 5 articles. 8000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 14, 21, 28, Feb. 4, 11, 1905. No. 67947 each D.

Tin.

Notes on the Mount Bischoff Tin Mine, Tasmania. Sydney Fawns. Information concerning the location, geological features, deposits, method of mining, &c. 3000 w. Min Jour—Jan. 21, 1905. No. 67524 A.

Zinc.

The Zinc-Smelting Industry of the Middle West. H. C. Meister. Deals with the western group, including Illinois, Missouri, Kansas, Wisconsin, and Indiana. Discusses the methods used. 4000 w. Am Inst of Min Engrs—Jan., 1905. No. 67576.

Zinc and Lead Deposits of Northern Illinois. From a paper by H. Foster Bain, discussing the geology, topography and ore deposits. 4300 w. Min Wld—Feb. 4, 1905. No. 67617.

Zinc Industry and Smelting in the United States. Walter Renton Ingalls. Explains the different conditions in the east and west, the gas smelters, and the increased cost of natural gas, &c. Min Wld—Feb. 18, 1905. No. 67856.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Grain Carrying.

The Grain Carriers. Map, tables and interesting information concerning the grain carrying railroads in the United States. 4000 w. R R Gaz—Vol. XXXVIII, No. 8. No. 68025.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Arrangement of Piping and Main Reservoirs to Prevent Water in Brake System. T. L. Burton. An illustrated explanation of systems of piping in use on various roads. 1200 w. Ry & Loc Engng—Feb., 1905. No. 67581 C.

Recording Air Brake Operations. An illustrated article showing the apparatus in use by the railway department of the International Correspondence Schools of Scranton, Pa., and giving extracts from records obtained. 1400 w. Ry Age—Feb. 17, 1905. No. 67827.

Brakes.

The Mechanical Action of Wheel-Block Car Brakes. Robert H. Smith. An explanation of brake action on railway and tramway cars. 2000 w. Engr, Lond—Jan. 27, 1905. No. 67692 A.

Braking.

Device for Regulating the Braking Power of Cars. Illustrated description of a device which regulates the retarding force applied to the wheels. 1800 w. Ry Mas Mech—Feb., 1905. No. 67632.

Car Wheels.

Rolled-Steel Car Wheels. Samuel M. Vauclain. Describes and illustrates the manufacture of these wheels, discussing their superiority and the great need in these days of heavy rolling-stock of securing a safe wheel. General discussion. 3000 w. Jour Fr Inst—Feb., 1905. No. 67723 D.

Couplers.

On the Question of Automatic Couplers (Subject VIII. for discussion at the seventh session of the Railway Congress). A. W. Gibbs. For America. Discussing the advantages and disadvantages, improvements, uses, &c. 10600 w. Bul Int Ry Cong—Jan., 1905. No. 67896 E.

On the Question of Automatic Couplers (Subject VII. for discussion at the seventh session of the Railway Congress). G. Noltein. Discusses the advantages and disadvantages, improvements in construction, use, &c. For all countries, except England and America. 11200 w. Table and fig. Bul Int Ry Cong—Jan., 1905. No. 67894 E.

Counterbalancing.

A Comparative Study of Locomotive Counterbalancing. Irving G. Downs. A study aiming to see approximately what effect the driving wheel still has upon the rail when counterbalanced by a generally accepted rule, and to make a comparison of the effects produced by the "Davis" type. Also discussion. 6800 w. Pro Cent Ry Club—Jan., 1905. No. 67814 C.

Locomotive Operation.

The Cost of Locomotive Operation. G. R. Henderson. A study aiming to give a clear understanding of the expenses with the effect of various influences. 2200 w. R R Gaz—Vol. XXXVIII, No. 7. Serial. 1st part. No. 67832.

Locomotives.

Advantages of Four-Cylinder Balanced Compound Locomotives. From "Record of Recent Construction," No. 49, issued by the Baldwin Locomotive Works, 1905. Discusses the advantages obtained and gives a record of test rules. Ills. 2000 w. R R Gaz—Vol. XXXVIII, No. 6. No. 67717.

A Michigan Central 2-8-0 Freighter. Illustrated description of a heavy consolidation freight engine. 600 w. Ry & Loc Engng—Feb., 1905. No. 67582 C.

A Recent Type of Italian Compound Express Locomotive. Dimensions, with illustrated detailed description of a locomotive of the "Italian crab engine" type. 450 w. Ry Age—Feb. 17, 1905. No. 67826.

Express Locomotives on the Bavarian State Railways. Illustration of one type of these engines, with description and dimensions. 1200 w. Engr, Lond—Jan. 27, 1905. No. 67693 A.

Freight Locomotive with Walschaert Valve Motion. An explanation of the Walschaert link motion, and an illustrated description of a Lake Shore locomotive, to which this valve gear has been applied. 700 w. Am Engr & R R Jour—Feb., 1905. No. 67603 C.

Narrow Gauge Tank Engine for Japan. Illustration, with brief description. 500 w. Ry & Loc Engng—Feb., 1905. No. 67580 C.

Prairie Type Locomotive for the Burlington. Brief illustrated description of new engines known as Class R-4. 500 w. Ry Age—Feb. 24, 1905. No. 68029.

Recent Locomotive Work on the Midland Railway. Charles Rous-Martin. The first of a series of articles reporting the performance by modern types of locomotives. 2290 w. Engr, Lond—Jan. 20, 1905. Serial. 1st part. No. 67541 A.

Six-Wheel Switcher, Southern Ry. Illustration and drawings, with description of switching engines for the Southern Railway. 500 w. Ry & Engng Rev—Feb. 18, 1905. No. 67863.

Tank Engines on Express Trains. Charles Rous-Martin. Discusses the suitability of these engines for fast running and some of the reasons pro and con. 4000 w. Engr, Lond—Feb. 10, 1905. No. 67879 A.

Tank Locomotives for Suburban Service on American Railways. A general summary concerning the use of tank locomotives for suburban service in the United States, giving brief illustrated descriptions of types used on various roads. 3000 w. Eng News—Feb. 16, 1905. No. 67807.

Train Lighting.

The Aichele Electric Train-Lighting System (Elektrische Zugbeleuchtung System Aichele). A single dynamo, driven from an axle, supplies current for the entire train, regulation being effected by a storage battery and automatic shunt. 2500 w. Elektrotech Zeitschr—Jan. 26, 1905. No. 67955 B.

On the Question of Lighting, Heating and Ventilation of Trains (Subject IX. for discussion at the Seventh Session of the Railway Congress). Charles B. Dudley. Considers improvements made in America. 1500 w. Table and fig. Bul Int Ry Cong—Jan., 1905. No. 67897 E.

Valve Gear.

Valve Gear for Four-Cylinder Compound Locomotives (Steuerung für Vier-Cylinder Verbudlokomotiven). Ernst Happel. Describing a modification of the Walschaert gear adapting it to both inside and outside cylinders. 800 w. Glasers Annalen—Jan. 15, 1905. No. 67928 D.

Wheels.

Proposed Specifications for Cast-Iron Wheels. C. W. Gennet, Jr. Gives specifications prepared with the purpose of defining the requirements of a satisfactory wheel and to provide for a method of testing. 1500 w. R R Gaz—Vol. XXXVIII, No. 6. No. 67719.

NEW PROJECTS.

New Construction.

San Pedro, Los Angeles, & Salt Lake Railroad. An illustrated account describing the new line from Salt Lake to the Pacific, including new and reconstructed lines. 3000 w. Ry Age—Feb. 10, 1905. No. 67737.

PERMANENT WAY AND BUILDINGS.

Construction.

General Engineering Features of the Denver, Northwestern & Pacific Ry. Brief illustrated description of the construction of this line between Denver, Colo., and Salt Lake, Utah. 1600 w. Eng Rec—Feb. 25, 1905. No. 68044.

Facing-Point.

High-Speed Facing-Points. An illustrated description of a new form of facing-point, called the St. George-Moore high-speed facing point, with explanation of the principle and the objects aimed to accomplish. 1400 w. Engng—Jan. 27, 1905. No. 67690 A.

Location.

Methods of Location on the Choctaw, Oklahoma and Gulf Railroad. Discussion of paper by F. Lavis. 3500 w. Pro Am Soc of Civ Engrs—Feb., 1905. No. 68048 E.

Power Plant.

The Chicago and Western Indiana Power House. Illustrated description of a plant for furnishing steam heat, compressed air and water supply to the coach yards and adjacent buildings, and for generating electricity for lighting passenger stations, freight houses, yard, subways, &c. 2000 w. Ry Age—Feb. 24, 1905. No. 68028.

Roundhouses.

New Roundhouses at Elkhart. Illustrated description of the arrangement of shops, power house and other buildings, and an account of the rapid inspection and repairs accomplished with the facilities at this Indiana plant of the Lake Shore & Michigan Southern Railway. 1600 w. Am Engr & R R Jour—Feb., 1905. No. 67602 C.

Shops.

New Shops of the Pere Marquette R. R. at Grand Rapids, Mich. Illustrated detailed description. 2000 w. Ry Mas Mech—Feb., 1905. Serial. 1st part. No. 67633.

Signals.

Block Signals on American Railroads. A discussion of signal arrangements in America from the English point of view. 1600 w. Engr, Lond—Jan. 27, 1905. No. 67601 A.

Block Signaling on Lines of Light Traffic. Describes examples on the Chesapeake & Ohio, and the manner of working, with comments on the conditions and cost. 2000 w. R R Gaz—Vol. XXXVIII, No. 6. No. 67718.

Modern Railway Signal Practice. Ernest C. Webster. A review of the development of fixed signals, with illustrations. 5000 w. Yale Sci M—Feb., 1905. No. 67892 C.

New System of All-Electric Interlocking. Illustrates and describes an installation at Millbury Junction, Ohio. 3800 w. Ry & Engng Rev—Feb. 18, 1905. No. 67862.

Signals and Signaling. George Sherwood Hodgins. An illustrated article describing the electric train staff system as used on four or five roads in the United States. 1800 w. Ry & Loc Engng—Feb., 1905. No. 67579 C.

Terminals.

Chicago Freight Transfers and Deliveries. A discussion of the subject as it appears in Chicago, explaining the plan suggested by Frederic A. Delano, describing present arrangements, the Illinois Tunnel Co.'s conduits, &c. Ills. 4800 w. Ry Age—Feb. 3, 1905. No. 67622.

Ties.

On the Question of Wooden Sleepers or Crossties. Selection of Species of Timber Used and Processes of Preservation (Subject I-A, for discussion at the seventh session of the Railway Congress). J. W. Kendrick. On the selection of the kinds of wood and the processes of preservation of railway ties. For America. 18000 w. Tables and fig. Bul Int Ry Cong—Jan., 1905. No. 67893 E.

Yards.

Chicago & Western Indiana's New Passenger Car Yard, Chicago. Illustrated detailed description of the construction and equipment of a new yard for cleaning and repairing coaches. 3300 w. Ry Age—Feb. 17, 1905. No. 67828.

STREET AND ELECTRIC RAILWAYS

Boston Tunnel.

The Equipment of the East Boston Tunnel. Considers features of interest in the roadbed, track, lighting, power supply, and ventilation systems, outlining the main physical characteristics of the tunnel. 3500 w. St Ry Jour—Jan. 28, 1905. No. 67553 C.

Braking.

A New Hydro-Electric Braking System. Illustrated detailed description of system designed by Charles A. Mudge. 1500 w. St Ry Jour—Jan. 28, 1905. No. 67556 C.

Car Storage.

Car Storage Houses vs. Operating Barns. D. F. Carver. Discusses the plans for storing out-of-service cars, and gives an illustrated description of the car-house for storage purposes built in Newark, N. J. 1800 w. St Ry Jour—Feb. 4, 1905. No. 67646 C.

Detroit Shops.

Shop Equipment of the New Repair Shops Installation of the Detroit United Railway Company. An illustrated account of some of the more important features of the mechanical equipment and operative methods. 3500 w. St Ry Jour—Feb. 18, 1905. No. 67861 C.

Electric Locomotives.

A New Shifting Locomotive for the Brooklyn Rapid Transit Company. Illustrates and describes an interesting electric locomotive especially designed for the shifting of cars. 1500 w. St Ry Jour—Feb. 25, 1905. No. 68031 C.

New Locomotives on the Valtellina Railway. Gives illustrations and interesting particulars of these locomotives, taken from an article by Béla Valatin, in *Elektrische Bahnen u. Betriebe*. 2000 w. Elec Engr, Lond—Feb. 3, 1905. Serial. 1st part. No. 67779 A.

Electric Traction.

Developments in Electric Traction. W. B. Potter. Compares alternating and direct current systems, gives statistics of steam and electric operation, describes recent equipment, and other features of interest pertaining to electric traction. General discussion. Ills. 19400 w. Pro N Y R R Club—Jan. 20, 1905. No. 67794.

Electrification.

Metropolitan District Railway Electrification. An illustrated comprehensive account of the electrical equipment of this underground road and of the great power-station at Chelsea. 34000 w. Tram & Ry Wld—Feb. 9, 1905. No. 67877 B.

The Electrification of the District Railway. Begins an illustrated detailed description of this work. 1500 w. Engr, Lond—Feb. 3, 1905. Serial. 1st part. No. 67791 A.

Fayet-Chamonix.

The Fayet-Chamonix Electric Railway. Dr. Alfred Gradenwitz. Illustrated detailed description of this line and its construction. 2000 w. Elec Engr, Lond—Jan. 27, 1905. No. 67677 A.

Fire Inspections.

Fire Inspections and Fire Precautions in Hartford, Conn. An illustrated account of the system of inspection in conjunction with methods of construction in all the buildings belonging to the Street Railway Company. 2000 w. St Ry Jour—Feb. 4, 1905. No. 67645 C.

Generating Stations.

See Electrical Engineering.

Interurban.

Completion of the Interurban Link Between Toledo and Detroit. Illustrated description of the new construction from Monroe to Detroit. The total length of the system as now operated is 56 miles, the extension embracing 35 miles of the distance. 4500 w. St Ry Jour—Jan. 28, 1905. No. 67552 C.

New York and Stamford Railway Co. Putnam A. Bates. Brief illustrated account of the railways consolidated to form this line. 2000 w. St Ry Rev—Feb. 15, 1905. No. 68015 C.

The Cœur d'Alene & Spokane Railway. Describes the situation and conditions in this region, giving an illustrated description of the railway and its equipment and operation. It handles freight as well as passengers. 1800 w. St Ry Jour—Feb. 11, 1905. No. 67741 C.

The Iowa & Illinois Railway Co. Illustrates and describes the line, power plant, rolling stock and operating methods of a recently completed interurban line between Clinton and Davenport, Iowa. 5500 w. St Ry Rev—Feb. 15, 1905. No. 68013 C.

The New Interurban Line of the Lansing & Suburban Traction Company. I. L. Dixon. An illustrated article briefly outlining the history of this undertaking and describing the line as now operated. 4500 w. St Ry Jour—Feb. 25, 1905. No. 68030 C.

The Street and Interurban Railway System at Terre Haute, Indiana. States the conditions which have led to the rapid increase in population in this district, and gives an illustrated description of the street and interurban railway development. 6500 w. St Ry Jour—Feb. 4, 1905. No. 67643 C.

Metropolitan Ry.

Sub-Stations and Automatic Signalling on the District Railway. Describes the Charing Cross sub-station as a type, and the system of signalling installed. Ills. 4700 w. Elect'n, Lond—Feb. 3, 1905. No. 67782 A.

N. Y. Subway.

New York Subway. Roger A. Selby. An illustrated article describing this great engineering work, and briefly reviewing its history. 3000 w. Yale Sci M—Jan., 1905. No. 67774 C.

Operation.

Electric Railway Operation in a Great City. H. H. Vreeland. Abstract of an address before the N. Y. Elec. Soc. Calls attention to points bearing on the electrical engineer in this branch of the industry. 4800 w. St Ry Jour—Feb. 25, 1905. No. 68033 C.

Paris.

Paris Metropolitan Railway Co. M. Vingoe. Illustrated description of line No. 3, extending from Courcelles to Père Lachaise, five miles, recently opened. 2000 w. St Ry Rev—Feb., 1905. No. 68014 C.

The New Paris Electric Railroad. C. L. Durand. Illustrates and describes the equipment of the Paris-Orleans electric railroad. 3200 w. Elec Rev, N. Y.—Feb. 18, 1905. No. 67830.

Philadelphia Subway.

The Subway of the Philadelphia Rapid Transit Co. Illustrated detailed description. 4500 w. Eng Rec—Feb. 25, 1905. No. 68045.

Power.

Steam Power. E. R. Roberts. Read before the Ohio Interurban Ry. Assn. Discusses the power needed for interurban electric railways, the operating conditions, and the importance of making comparisons on the basis of operating conditions. 5000 w. St Ry Jour—Feb. 11, 1905. No. 67743 C.

Power-Distribution.

The Power Distribution System of the Louisville Railway Company. Illustrated description of an extensive polyphase power-distribution system recently installed. 1400 w. St Ry Jour—Feb. 11, 1905. No. 67742 C.

Prime Movers.

Steam Power for Electric Railways. E. P. Roberts. Read before the Ohio Interurban Ry. Assn. Discusses the factors to be considered in deciding upon a prime mover, giving a special study of steam power, the effects of grades, cost, &c. 4500 w. Eng Rec—Feb. 18, 1905. No. 67849.

Repair Shops.

The New Repair Shop Plant of the Detroit United Railway. An illustrated account of the new repair shop installation and the methods pursued there. 3800 w. St Ry Jour—Feb. 11, 1905. No. 67740 C.

Service.

Limited Service and Interline Business. A review of the conveniences and possibilities for fast long distance travel on electric railways. 4500 w. St Ry Jour—Feb. 4, 1905. No. 67644 C.

Shop Methods.

Shop Methods at the Repair Shops of the Detroit United Railway Company. A supplementary article to two preceding, relative to this new repair shop. Describes method of handling cars, truck shop, erecting shop, storage air brakes, &c. Ills. 6000 w. St Ry Jour—Feb. 25, 1905. No. 68032 C.

Single-Phase.

Opening of the Indianapolis & Cincinnati Single Phase Line. Illustrated detailed description of the road and its equipment. 4000 w. St Ry Jour—Feb. 18, 1905. No. 67859 C.

The Indianapolis & Cincinnati Traction Company. Illustrates and describes a practical application of the single-phase system to an interurban railway. 4500 w. Elec Rev, N. Y.—Feb. 18, 1905. No. 67831.

Snow Removal.

Snow Removal in Syracuse. E. G. Connette. Brief illustrated account of methods found successful in a city subject to heavy snow fall. 600 w. St Ry Jour —Jan. 28, 1905. No. 67554 C.

South Africa.

Electrical Installations of the Natal Government Railways, South Africa. An illustrated description of the new power station at Durban, and its equipment. 2500 w. Elec Rev, Lond—Feb. 10, 1905. No. 67872 A.

Tokio.

The Tokio Tramway Company. E. A. Baldwin. Brief illustrated description. 1000 w. St Ry Jour—Feb. 18, 1905. No. 67860 C.

Tracks.

New Track Systems for City Streets. Gives views recently expressed by street railway officers, with illustrations of various types of construction. 1700 w. Eng Rec—Feb. 25, 1905. No. 68043.

Recent Methods of Construction and Pavement of Tracks in Boston. Arthur L. Plimpton. Illustrated detailed description. 700 w. St Ry Jour—Feb. 4, 1905. No. 67647 C.

Valtellina.

Experiences and Results with Polyphase Current on the Valtellina Railway (Erfahrungen und Ergebnisse mit Hochgespanntem Drehstrom auf der Valtellina Bahn). Eugen Cserhati. Results of the past two years' operation, showing the success of the line from a technical and commercial standpoint. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 28, 1905. No. 67907 D.

Wheels.

Wear of Steel Tired Wheels—How to Eliminate Excessive Flange Wear. W. G. Price. Considers the cause of excessive wear to be due to faulty truck construction. 1000 w. St Ry Rev—Feb. 15, 1905. No. 68016 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Industry. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Trans. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

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"THE WORLD IS ITS FIELD"

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MODERN EXCAVATING MACHINERY FOR THE PANAMA CANAL.

By A. W. Robinson.

II. AVAILABLE TYPES OF SPECIALIZED DREDGING PLANT.

Recent events—particularly the complete reorganization of the Isthmian Canal Commission and the expected formation of an international consulting engineering board—have again brought the Panama Canal into the forefront of interest among all the great constructive enterprises of the world. Mr. Robinson last month reviewed the methods followed in similar huge undertakings preceding. In the present article he gives an admirably clear idea of the machinery now available and best adapted to the several sections of the canal.—THE EDITORS.

HAVING touched in a preceding article upon the methods employed in building some of the great canals of the world and their costs, let us look a little at the types of dredging plant now available and which would be suitable for Panama Canal. With modern appliances of great power and capacity we undoubtedly have a great advantage over earlier works in being able to accomplish more excavation in less time and with less labor. In considering the advantage of these modern appliances, we must always remember that at Panama we have to contend with the disadvantages of climate, remoteness, and high cost of skilled labor. Therefore it is essential that the appliances should be specially designed as far as possible to minimize these disadvantages, the ill-effects of which can be reduced by perfect sanitation, and by making the shovels and dredges as comfortable and easy to operate as possible. The rainy season will undoubtedly make steam-shovel work uncomfortable and slow, but need have little effect on dredge work as the men can be comfortably housed. Remoteness will affect the cost and must be especially provided for as to strength and durability of all machinery. High cost of skilled labor must be met by adopting methods that will produce large results with a minimum of labor.

Beginning at the sea-harbors at both ends of the Panama Canal, we have several modern types of dredge available. For sandy bottom in exposed sea positions we have the sea-going sand-pump hopper dredge. This is a sea-going vessel which can work in any ordinary weather without anchorage. It passes slowly over the channel, picking up its load of sand, and when full lifts its suction-pipe, proceeds to sea, and dumps its load. Such a dredge may have a hopper capacity of 1,000 to 2,500 cubic yards and can make from 5 to 8 loads per 10 hours, depending on the distance to the point of deposit. It is not adapted for material that will not settle or precipitate in the hoppers.

For harder material in open harbor or channel way, the endless-chain barge-loading dredge is well-adapted. In Europe the endless-chain is the favorite type for all classes of excavation, both wet and dry. On the Suez Canal and the North Sea Canal it was the exclusive type. In view of the development of the single dipper machine, the endless-chain dredge should now be restricted to open channel work, dealing with large volumes of material over wide areas and loading into barges. This type of dredge makes a true and level bottom, is not injuriously affected by tides, currents, or moderate sea, can deal with fairly hard material at a rapid rate, and has greater mechanical efficiency than any other type—that is, it will excavate more cubic yards per horse power. Such a dredge is built in the form of a steel self-propelled vessel and may be designed to dredge 800 to 1,000 cubic yards per hour from a depth of 40 feet economically. It can make a cut 500 feet wide at one time and cover the ground absolutely so that no lumps are left. Such a dredge requires plenty of sea-room for effective work, and its anchor chains require careful watching in situations where they obstruct navigation.

In Europe the endless-chain type is still used for all kinds of work and for dry excavation, but for any other conditions except those stated it cannot compete with the dipper dredge, the steam shovel, and the hydraulic dredge, each for their respective lines of work. No endless-chain dredge can do the variety of work in confined situations that a dipper dredge can do, and no chain excavator such as was used on the North Sea and Manchester Canals, and on the Panama Canal by the French Company, can equal the American type of steam shovel, either in point of power, speed, adaptability, or economy of labor. The divergence of practice between Europe and America is here well illustrated. In Europe the endless-chain type is developed to its greatest extent. In America the single dipper type, first evolved by the necessity of the small contractor for a light and cheap tool, has been developed until in the modern dipper dredge for sub-aqueous excavation and in the steam shovel for dry work, we have machines better adapted for American conditions than any other.

For general purpose dredging in hard material in more sheltered situations and over confined areas, the dipper type of dredge is well adapted. This type has a single dipper of great strength and power. It is anchored by means of spuds and can either load the material into scows or cast it upon the bank. This type of machine is distinctly American, and has a wide range of adaptability. It has the advantage over the endless-chain dredge of simplicity, of requiring a smaller crew, and of less first cost, although the cost per unit of capacity is about the same. An efficient size of dipper dredge for 40-foot depth is one having a hull about 40 feet wide by 120 feet long, and having a dipper of 6 cubic yards. It can make a load every 40 seconds, or a rate of 540 cubic yards per hour. A dipper dredge of these dimensions working in clay in Boston harbor loads a 1,400-yard scow in 3½ hours and has made as much as 125,000 cubic yards per month. As the performance of this type of dredge depends continually upon the activity and skill of the operator, the levers should be designed to be as convenient as possible and power-operated with little or no manual effort. If a man has to work to push these levers, as in the North, he will do much less work in the enervating climate of the Isthmus. If, on the other hand, he can sit in a comfortable seat and make all the powerful motions respond instantly to the touch of a finger, there is no reason why this type of dredge should not be as active in its movements as in the more bracing climate of the North, where it frequently makes a speed of two dipper loads per minute.

For soft material that must be loaded into barges we have the grapple or clam-shell dredge. This type has reached a high efficiency on the Atlantic Coast and can also be used for picking up blasted rock when fitted with a specially constructed stone grapple.

In several sections of the Canal some rock will be encountered, and the best method of treatment for such deposits will be a matter of special study after the conditions are more fully known. Some kinds of rock can be economically dredged by a powerful dipper or ladder dredge, and for other kinds blasting is resorted to. For all work of this kind the machinery should be of the strongest possible description and every precaution observed to avoid breakdowns and repairs. Rocky material will be useful in many ways in the construction of the canal, and can be loaded on deck scows, towed to destination, and unloaded by clamshell derricks and deposited where required.

For soft material, sand, or homogenous clay more or less stiff that can be delivered to its destination by pipe-line, we have the hydraulic type of dredge. This type of machine is built in a variety of forms to suit different conditions and it is one of the most recently developed and most valuable types. It places in the hands of the engineer the means to dig and at the same time transport and distribute enormous volumes of clay or soft material at a low cost. Various examples of this and other types of dredging apparatus have been described in previous papers by the writer* so that they are not gone into here. In those papers the great carrying power of pipes of even a moderate diameter was pointed out. Hydraulic dredges are specially adapted to deal with soft material in large quantities and to pump or deliver the material through pipe lines to a distance. This distance may be efficiently as much as 2,000 to 3,000 feet; beyond that great power is absorbed by friction in the pipes.

The percentage of solid matter that can be transported in pipes with water depends on the nature of the material and on the efficiency of the apparatus employed to cut and feed it into the mouth of the suction pipe. Until recently is has been supposed that this type of dredge was adapted to pumping sand only, or very soft material. Now, however, we are able to deal with stiffer materials than heretofore by using powerful cutting or digging apparatus and employing the pump and pipe-line for purposes of transportation to the place of deposit. Clay soils especially lend themselves to this method and can now be worked more efficiently than sand, for the reason that the wear or abrasion of pump and pipes is less and a higher percentage of solid matter can be pumped without precipitation or clogging. Clay, once fed into the suction pipe uniformly and with a proper admixture of water, can be pumped through by a good pump with large passages and sufficient power. The crucial point is in the cutter, which should be of great strength to avoid breakage and special design to suit the material and to avoid clogging.

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* See "Modern Machinery for Excavating and Dredging," THE ENGINEERING MAGAZINE, March and April, 1903. Also "Dredges: Their Construction and Performance." International Engineering Congress, St. Louis, 1904.

The great possibilities of this method of transporting spoil may be gathered from the fact that the carrying capacity of a 30-inch pipe, at 15 feet per second and 25 per cent. solid matter, is 2,500 cubic yards per hour, and other percentages in proportion. These dredges can be built efficiently up to capacities of 2,000 to 4,000 cubic yards per hour for pipes that do not have to be handled ashore, and up to 1,500 to 2,000 cubic yards per hour for shore discharge.

For those sections of the Panama Canal which lie in the coastal plains, as from Colon to Bohio on the Atlantic side and from Miraflores to Panama on the Pacific, hydraulic dredges may be used effectively to deal with all the soft material. In these sections of the work it is of the first importance that no manual labor should be necessary on shore, as the banks are covered with tropical vegetation and it would be difficult, if not impossible, to handle large discharge-pipes on shore under such conditions. The first requisite for hydraulic dredging in those sections is to throw up a large embankment on either side to retain the material deposited. Such an embankment may be made by a powerful dipper dredge, making its own channel and casting on the bank. Such a dredge could cut through any obstructions in its way and not a man need step off the dredge. This operation done, we have two small canals and two embankments defining the margin of the great canal, with a core of material in the center. This central core can then be taken out by a great hydraulic dredge with a suspended discharge-pipe long enough to reach over the top of the embankments, from which the material would distribute itself over a wide area by the action of the water. This suspended pipe would be carried by a separate pontoon, which could be at a variable distance from the dredge and permit the deposit of the material in special places. Thus not a man would set foot ashore in either operation, and the dredges would be fitted with comfortable upper decks containing living quarters for the crew, and be especially designed to operate with as little labor as possible. With Texas oil for fuel, and powerful well-designed machinery, the work of running such a dredge would be confined to skilled supervision, manual labor being reduced to a minimum.

How vastly different this from the Suez methods! There, when slaves were not actually engaged in digging with their hands in the broiling sun, the laborious chains of buckets of the dredge lifted up the sand and spouted it on the bank, only for much of it to run back again. The work of the American Contracting Company at Panama, who in the eighties employed chain-bucket dredges with long spouts, was also of this description; and it is notorious that they got paid several times over for much of the material. The elevator dredge with long spout is obsolete for canal work, and we now have tools of far greater efficiency and capacity, which can be run with smaller crews, and which will put the material where it is required.

At Panama the cost of skilled labor will undoubtedly be high, and the climate is such that great physical effort is impossible. Hence the absolute necessity of adopting the most labor-saving machinery, and of maintaining a large output per man. With a large output per man the burden of high wages disappears. To pay a man $250 per month to run a dredge producing 12,500 cubic yards a day is a tax of only a tenth of a cent a yard; but if the output is small the wage item becomes more serious. To maintain large outputs, it is essential that the very best design and workmanship be used in the construction of the plant and the best management in its operation. Every point that might develop trouble or weakness must be carefully guarded against, and for this experience is a pre-requisite.

Coming now to the high-and-dry section of the canal, the main reliance will be placed on the American type of steam shovel. Seventeen of these machines have already been ordered by the first Commissioners, three of which at this writing are at work and have already demonstrated their ability to reduce materially the cost of excavation in this section. As the work becomes better organized the results will continue to improve. The hard clay of Culebra cannot be more difficult than iron ore of Mesabi, and we find shovels there making a daily average output of 3,000 tons, or equal to say 2,000 cubic yards of clay. Assuming the Culebra cut to contain 45,000,000 cubic yards down to the 50-foot level, and that at Panama a shovel can make only 1,500 cubic yards a day of 24 hours for 200 days a year, this portion could be done by 50 shovels in three years. (50 × 1500 × 200 × 3 = 45,000,000) Several of our great railroads are today doing as much excavating in their improvements of grade-reductions, &c., and nothing is said about it, and a larger volume has been handled by steam shovels in the iron-ore ranges of the North. Hard clay such as exists at Culebra is favorable to steam-shovel work, and this great cut, about the immensity of which so much has been said, has really now become one of the least difficult portions of the work. Should it be decided to make a deep cut to sea level, the volume of excavation will then indeed be colossal—the largest in one place ever undertaken by man; but with our present tools, still further improved in the light of experience, the date and cost of completion of this deep cut can be fairly, closely and accurately determined.

The Culebra cut was attacked by the old French company with land excavators of the endless-chain type. These machines successfully excavated the North Sea Canal where the material was mainly dry earth and the cost of labor low, but at Panama the results were very different. As pointed out in the previous article, the large crew and expensive track required, together with inability to dig hard materials, are the most serious shortcomings of this machine; and they are inherent in the type, and cannot be remedied by improving the design. It has been thought that a continuous chain of buckets must necessarily have greater capacity than one bucket working intermittently, but this is not so. It is a large chain-bucket excavator which has buckets of ¾-cubic-yard capacity. Such a machine at 13 buckets per minute will have a rate of 9.75 cubic yards per minute. A common size of steam shovel will have a dipper of 3-cubic-yards, will readily work at 3½ dippers (or 10½ cubic yards) per minute, and can occasionaly make as much as 4½ dippers per minute, or 13½ cubic yards per minute. Furthermore, a single powerful dipper of 3-cublic-yards capacity with 60,000-pounds pull applied to it can do far more excavation in hard material than a light bucket of ¾-cubic-yard or a flexible chain carried by a ladder frame.

A greater problem than the actual excavation is the disposal of the spoil, and this item will probably exceed the mere cost of loading the cars by steam shovel. An organized system of tracks is necessary, so that trains of large capacity can be circulated and fed past the shovels as nearly continuously as possible.

The importance of this as affecting the work done by the shovels can hardly be overestimated. The working rate of a 3-yard shovel at 3½ dippers per minute is 10½ cubic yards per minute, or 630 cubic yards per hour. Under working conditions, if one half of this rate is realized it is counted as good work, and it is frequently less than this.

The most effective size of shovel for Panama will be one having a dipper of 2½ or 3 cubic-yards capacity for hard material, and 4 cubic-yards for soft. The shovel should not weigh more than 70 to 75 tons, and should exert a pull upon the dipper of not less than 50,000 pounds. It should have power-operated levers so as to handle with ease, and be as speedy as possible. Larger shovels have been tried, but above 75 tons in weight and 4-cubic-yards capacity of dipper the machine becomes more difficult to handle and slower in its movements, and more stuff is spilled while loading. A shovel should not be too large for the cars it is to load, in order to do clean work.

In this connection mention may be made of the possibility of using hydraulic transportation for the spoil of Culebra cut. If it should prove possible to lay on a large supply of water at any reasonable cost, the material excavated by the shovels may be carried by pipe line direct from a hopper alongside the shovel and distributed in the lower ground and valleys within reach. The carrying capacity of pipe lines of hydraulic dredges has already been touched upon, and in this case the operation would be aided by gravity. The softer deposits of material may even be washed down by direct hydraulic action of powerful jets similar to hydraulic mining.

As the work advances it will undoubtedly be necessary to design and build special machines to suit the conditions as they arise, and in this way further advances in the art will be made. No plant is in existence today that would be adequate or suitable to Panama conditions. Improvements have followed so rapidly and continuously that machines employed on previous works are obsolete. The improvements are in many cases only of detail; but efficiency of detail governs the efficiency of the whole, and too much attention cannot be paid to details in building dredging machinery. In the item of steam shovels alone, patterns of detail have entirely changed within the last five years, and more changes are now in progress to meet the demand for more power, more speed, and greater efficiency.

In conclusion it may be said that with the modern tools now available great economies may be effected and large volumes of material excavated and disposed of by mechanical means with less manual labor than ever before. Just how much saving can be effected under Panama conditions it is impossible to foretell, and the figures must be determined by experiment. The unquestioned superiority of modern tools will greatly reduce former costs. The high cost of labor and climatic conditions, in that proportion do we increase their efficiency as we can render the modern appliances independent of labor and climatic conditions, in that proportion do we increase their efficiency at Panama.

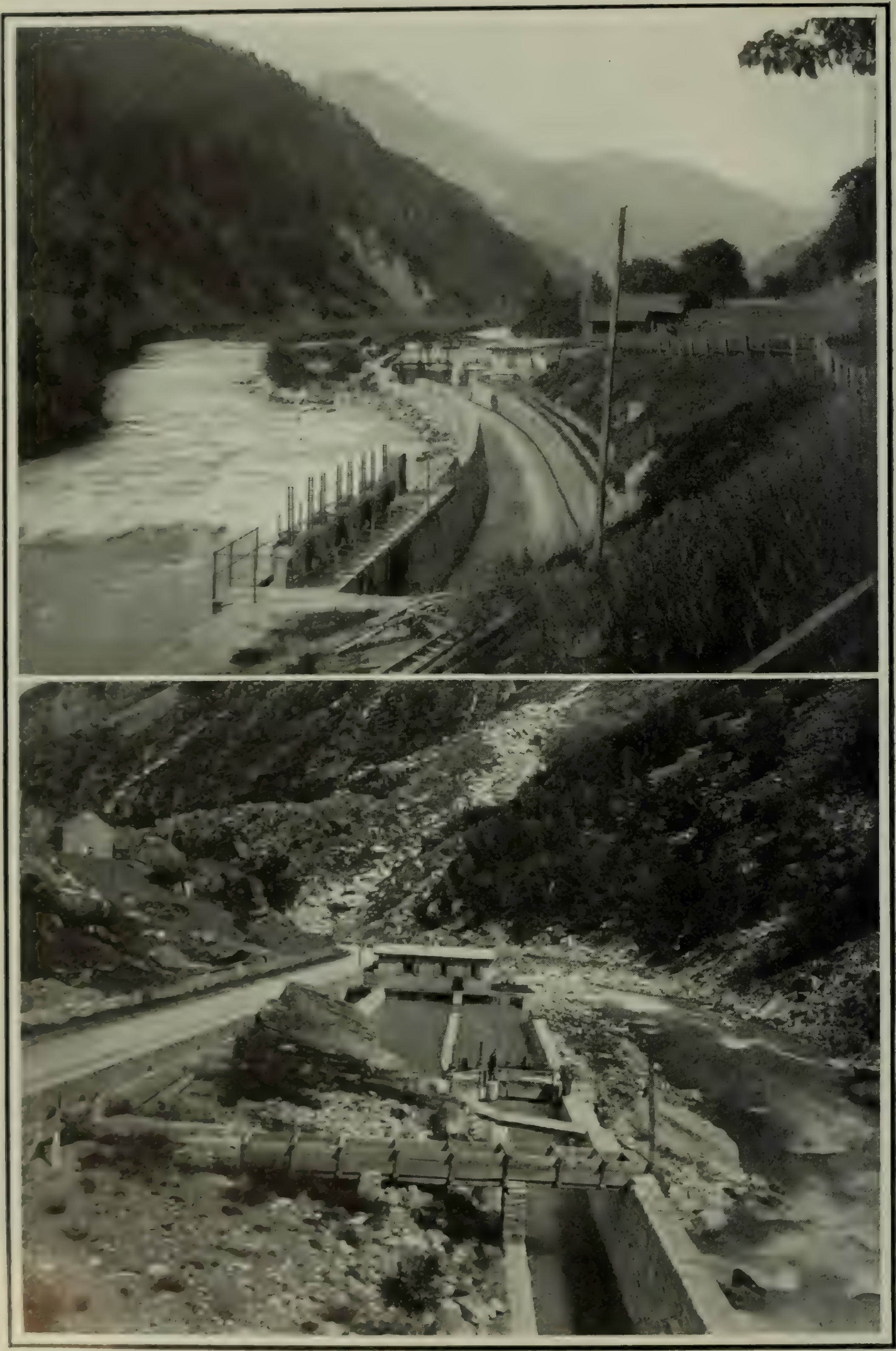
THE CONSTRUCTION OF THE SIMPLON TUNNEL.

By Leon Monete.

On the 24th of February the two portions of the tunnel, which had been worked from either side of the mountain towards the center, came in contact, and at 7.20 A. M. the first drill coming from the Italian side penetrated through the intervening space, thus marking the completion of the great enterprise which had been carried on amid so many difficulties. The Simplon tunnel, with its total length of 12 miles, pierced through the mountain at a depth of nearly 7,000 feet below the surface, is to be ranked among the great engineering achievements of the century, and in its proportions it surpasses anything of the kind which has been previously attempted. Thus the Simplon tunnel is finally run through the mountain, solving the great technical, economic and financial problem which was the object of so much attention for half a century.

AT the beginning of the last century, Napoleon constructed, at an expense of $3,500,000, a route over the Simplon, which led from Brigue, in Switzerland, to Domo d'Ossola, in Italy, and thus seemed to mark out the path for a great international railroad. More than fifty years of study and discussion were necessary, however, before the latter great work could be brought to a successful issue. The first project for a tunnel through the Simplon dates from 1855, but at that time the political conditions were not favorable to its execution. Later on, the Mt. Cenis route was preferred; then came the St. Gothard tunnel, which was carried out by the inspiration and aid of Germany in order to increase the traffic between Germany and Italy. When the Simplon route was finally taken up, the delay had at least one advantage in giving the new tunnel all the recent improvements in underground methods which had developed within late years. In fact, each of the new tunnels was marked by a series of progressive stages in engineering work. Mt. Cenis used mechanical drills, which replaced the old mine chisel and allowed of piercing a 7-mile tunnel, an achievement then without precedent. At St. Gothard, dynamite was substituted for powder, and shortened up the work considerably. In the case of the Simplon tunnel, the progress which had been realized in drilling, owing to the use of hydraulic and electric power, allowed the engineers to attack a 12-mile tunnel without hesitating, and this is the longest which has yet been constructed.

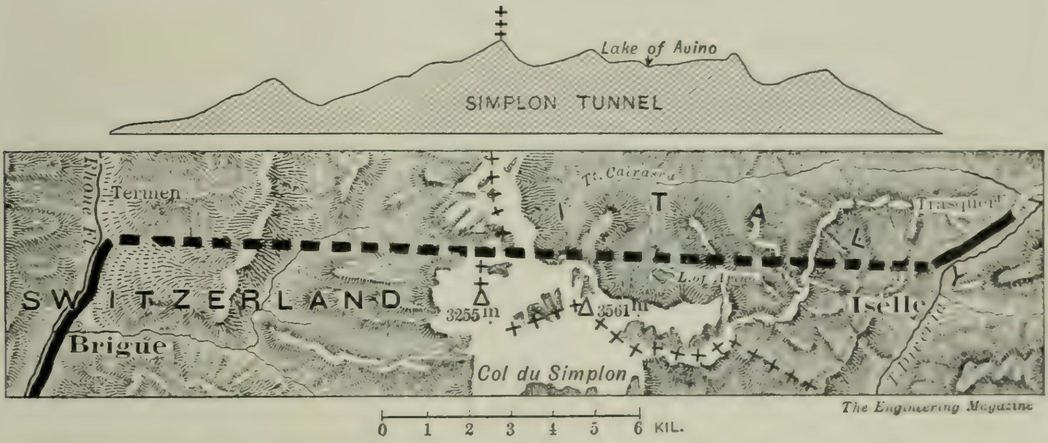
There were no less than twelve projects for the work of the tunnel, and these can be divided into three general classes—low,



HYDRAULIC CANALS AT THE OPPOSITE ENDS OF THE TUNNEL.

That shown above is the one drawing water from the Rhône, on the Swiss side; the one in the lower picture is on the river Diveria, on the Italian side. The hydraulic power was used in driving the tunnel.

medium and high tunnel, according to the altitude. The base or low system was finally adopted; although it makes a longer tunnel, it is easier to connect with the railroad at either side, without using too heavy grades. The construction of such a tunnel offered special difficulties which could not have been overcome twenty-five years ago, and the engineers were obliged to take many precautions in carrying out the work, especially as regards hygiene and ventilation. The mountain is 1.2 miles high above the tunnel in some places, and at such a great depth the heat becomes excessive. The workmen had to support a temperature of 95 to 104 degrees F., while it was only 84 degrees at Mt. Cenis and 86 at St. Gothard. Special powerful air fans had to be used, and water sprays were employed to cool the inside of the tunnel.



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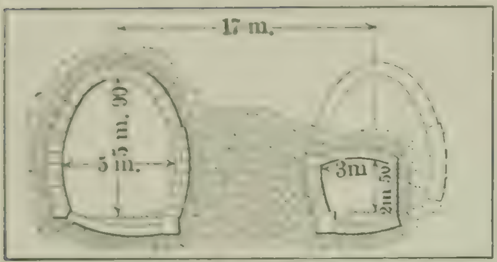
MAP SHOWING THE LINE OF THE SIMPLON TUNNEL.

The mass of the Simplon, which separates the Rhone basin from that of the Loce, in Italy, forms a high rampart between Switzerland and Italy, with several summits of considerable altitude, such as the Monte Leone (11,600 feet), the Wasenhorn (10,580 feet), and the Furggenbaumhorn (9,720 feet). The railroad which is to pass through the mountain starts from the station of Brigue, which is the present terminus of the Swiss railroad, passing along the shore of Lake Leman, mounts 1½ miles along the left bank of the Rhone, and curves to the right, entering the tunnel. The latter is directed from northeast to southwest, and measures 19,803 meters (64,960 feet) in length. It comes out on the Italian side near Iselle, a small place on the Diveria River, and 9 miles from the Italian railroad terminus at Domo d'Ossola. Here the Simplon railroad will join the Italian line which passes to Milan.

From the entrance of the tunnel the track rises slightly each way to the middle (0.7 per cent.), so as to drain off the water. The



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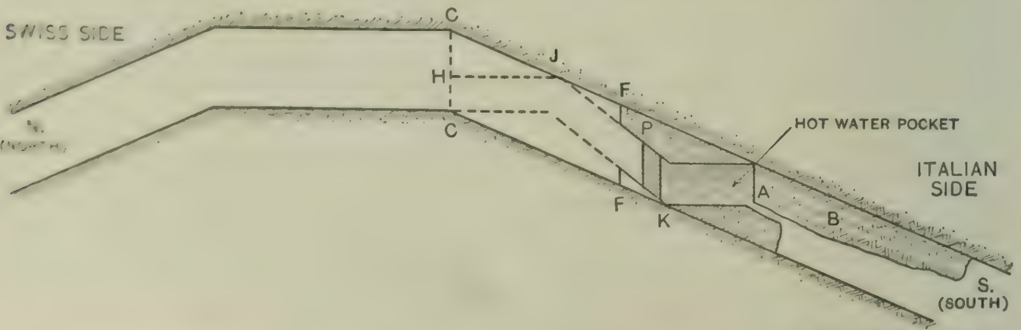
SECTIONS OF MAIN AND SECOND TUNNELS.

The dotted lines in the right-hand figure represent the eventual enlargement. The small tunnel now serves to ventilate (by cross-cuts) the main one.

Italian-Swiss frontier is crossed at 5.5 miles from the north end, and it is also at this point that the mountain has its greatest height. What distinguishes the Simplon from the other great tunnels is that instead of using a double-track tunnel, it is laid out to form two single-track tunnels lying parallel and at 55 feet distance between the centers. This solution has the advantage of allowing the construction of the second to be postponed until the increase of traffic makes it necessary, but it also offers a convenient and economical method of building the first tunnel and gives a good ventilation. The work was begun by piercing the two advance headings of each tunnel, and these were connected by short cross-galleries at every 600 feet. Only one of the tunnels is enlarged to the final dimensions—19.5 feet high and 10 feet wide. This forms the single-track tunnel No. 1, while the other drift, which is to be tunnel No. 2 in the future, now serves as a ventilating gallery for the first. During the work, the second gallery was used to a great advantage for ventilating, draining off the water, and transporting the materials. Here were placed the high-pressure water pipes for the drills and for washing down the débris after each explosion. The trains which pass through the tunnel on single track are to cross in the center, and here the project carries the design of an underground station some 1,600 feet long, where the two tunnels will be joined in one. The station will somewhat



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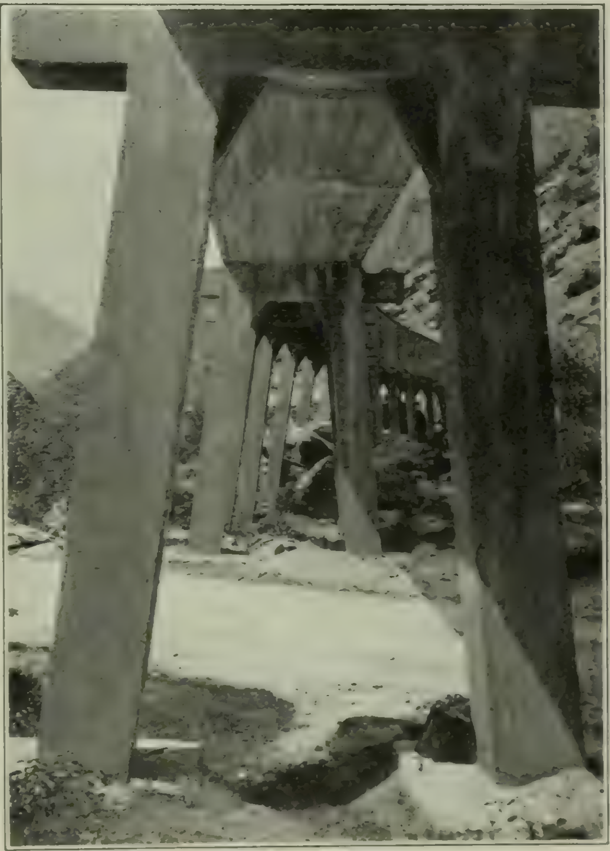
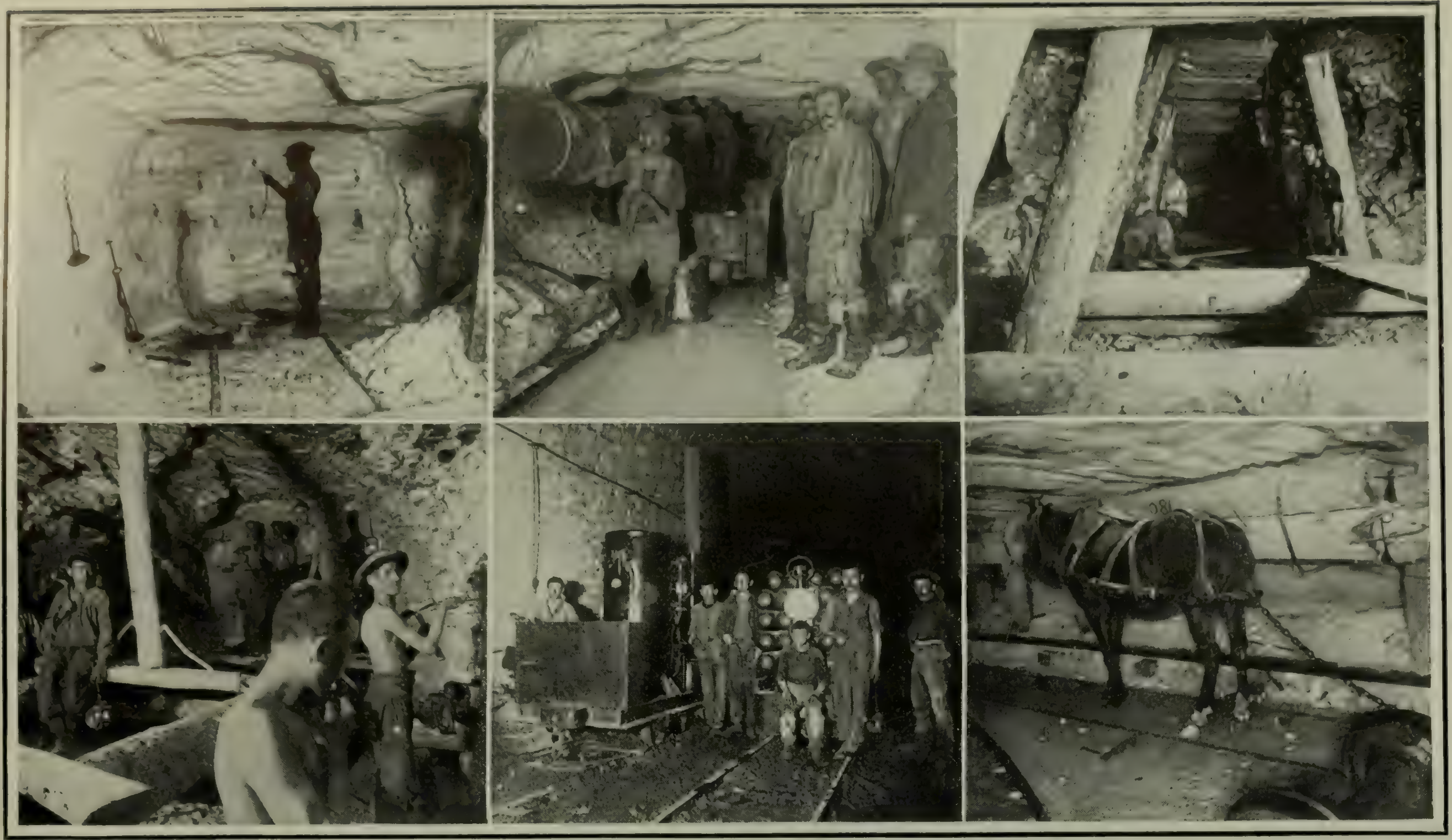
SECTION SHOWING THE MEANS USED FOR CONFINING AND CONTROLLING THE HOT-WATER FLOW.

FF, temporary end of workings from Swiss side; P, iron door confining the hot water which first flooded the workings; A, entrance made by the drills, working from the Italian side.

resemble a subway station, with the difference that the passengers have a thickness of 1.6 miles overhead. The ventilation of the tunnel was carried out during the work by large air fans of 500 horse power each. These could deliver as high as 130 cubic yards of air per second to the working points, and were always in operation. Hydraulic power was the main source of energy for the Simplon tunnel. It operated the drills, aided in taking off the residues, cooled the working face, and also produced electricity. The water was brought to the outer ends of the tunnel by long canals in reinforced concrete, one from the Rhone and the other from the Diveria.

The drilling of the tunnel was commenced on August 1, 1898, and according to the rate of advancement it was supposed that the work would be finished about May 1, 1904; but considerable delay came from the springs of hot water which were met with unexpectedly in several places and flooded the tunnel at various times. It was the great abundance of water, more than the high temperature of the tunnel, which caused the most difficulty throughout the work. The Simplon, like the other great tunnels, has a sloping profile, with the highest point in the center and a slight grade on either side towards the mouth. This allows the water to be easily drained off in ordinary cases. If the headings had been advanced with the same rapidity on both sides of the tunnel the two working points would have met in a point at the middle of the tunnel or about the highest altitude. This was not the case, however. The Swiss side advanced more rapidly at first, as the flow of water was less than on the Italian side, being 10 gallons per second against 200 gallons. The Swiss

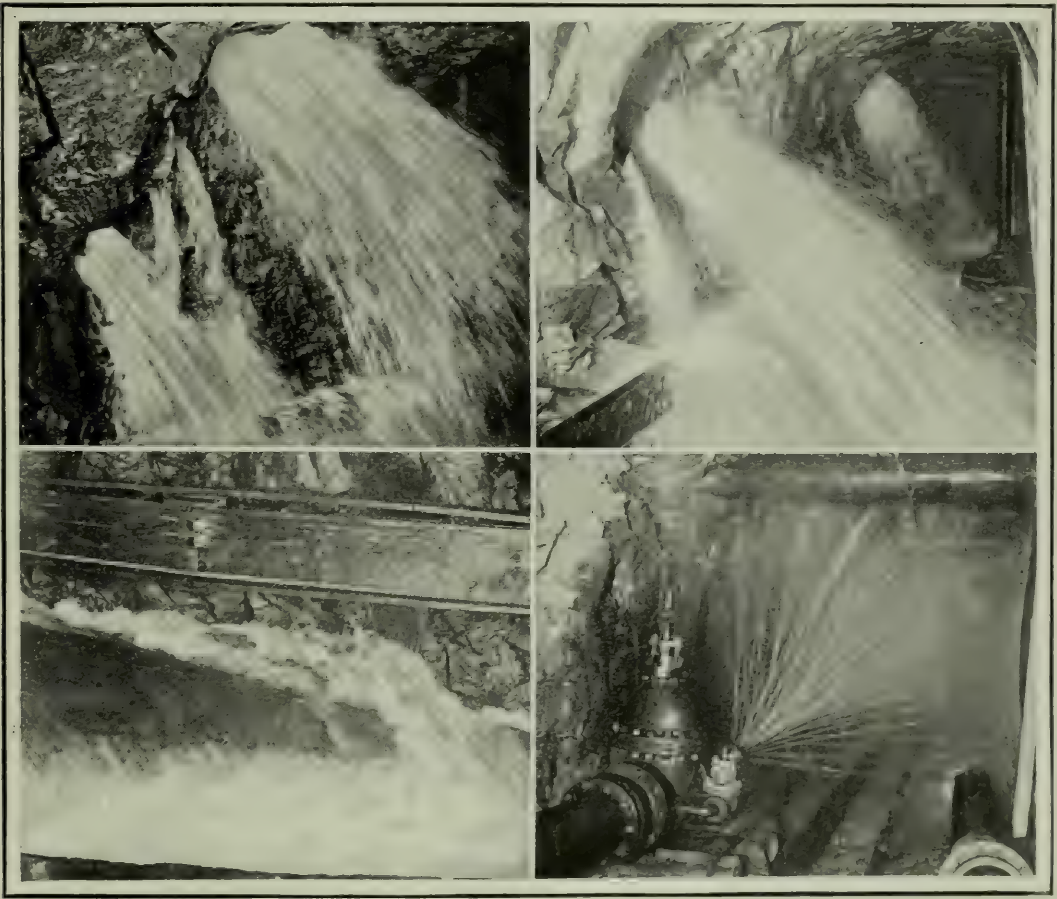

REINFORCED CONCRETE FLUME CARRYING THE HYDRAULIC CANAL FROM THE RHÔNE.



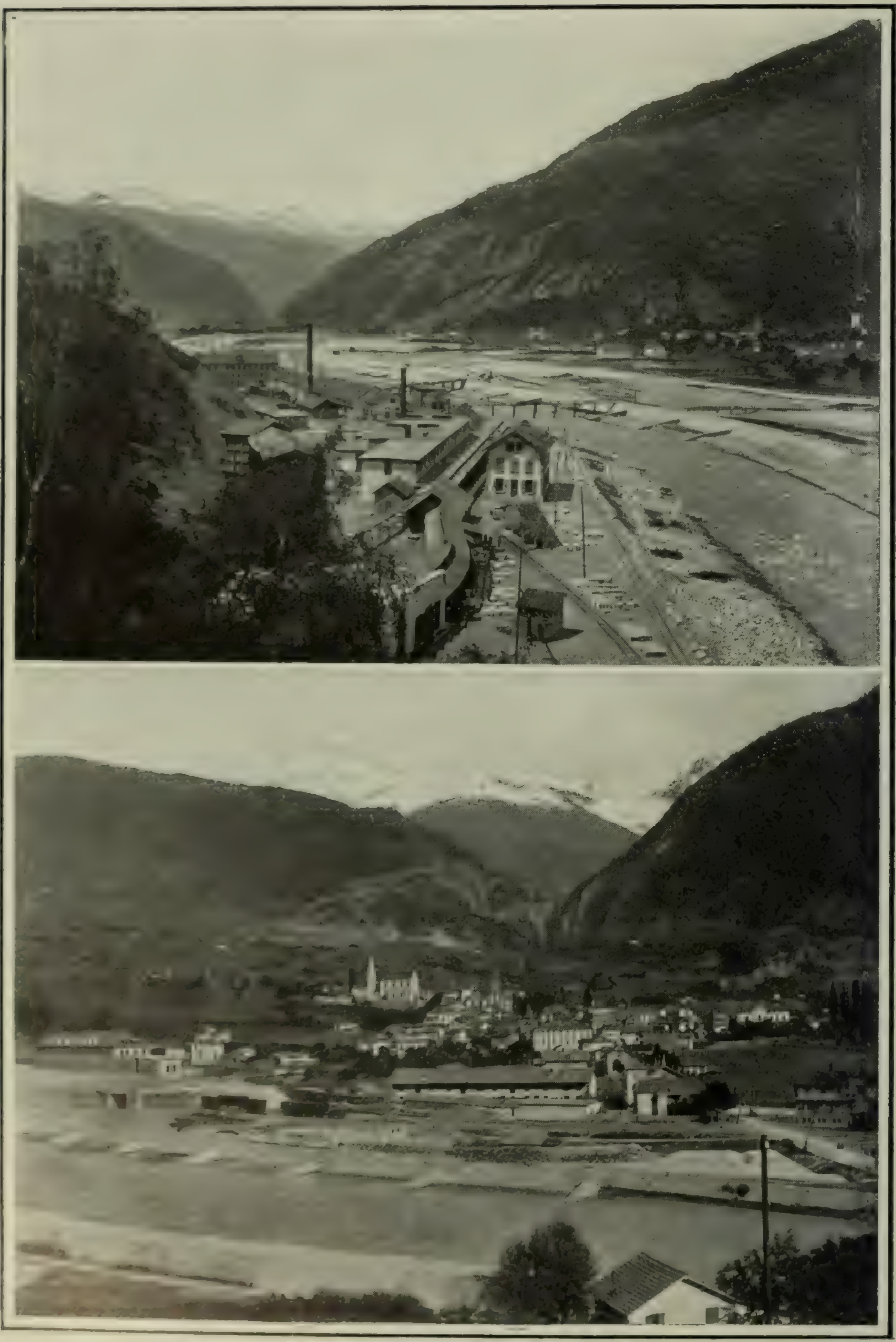
UNDERGROUND WORK IN THE CONSTRUCTION OF THE SIMPLON TUNNEL.

From left to right, the views show:—In the upper tier, 1, preparing to fire the shots; 2, the first heading; air conduit on the left; 3, in the heading. In the lower tier:—4, enlarging the section; 5, compressed air locomotive and reheater; 6, horse haulage in a cross-cut.

side thus passed the middle point in the early part of 1904, and then commenced to descend the southern slope of the tunnel. But during the work a very heavy outflow of water was encountered which obliged them to suspend operations altogether on that side. As the water could not be drained off, it was decided to confine it at least to the end of the tunnel, and a heavy iron door was mounted across the tunnel about 800 feet from the end. This formed a reservoir or pocket containing some 4,000,000 gallons of hot water at a temperature of 120 degrees F. The drills on the Italian side kept gradually approaching the front end of the pocket, and the sounds of the work could be heard from either side. For the last few days the drills advanced with great precaution. Then came the moment when one of the drills bored through the last space in front of the reservoir and the water commenced to filter through. When the drill was withdrawn a jet of water followed it, and the long-expected moment arrived when the tunnel was completely pierced. Afterwards the



SOME SUGGESTIONS OF THE WATER PROBLEMS OF THE TUNNEL WORK.
The two pictures in the upper tier are springs encountered at kilometre 4.442 and 4.436 respectively. On the left below is shown the water flowing into the drainage channel. The lower right-hand figure is a cold-water spray for reducing the air temperature.



BRIGUE, AT THE SWISS END OF THE TUNNEL.

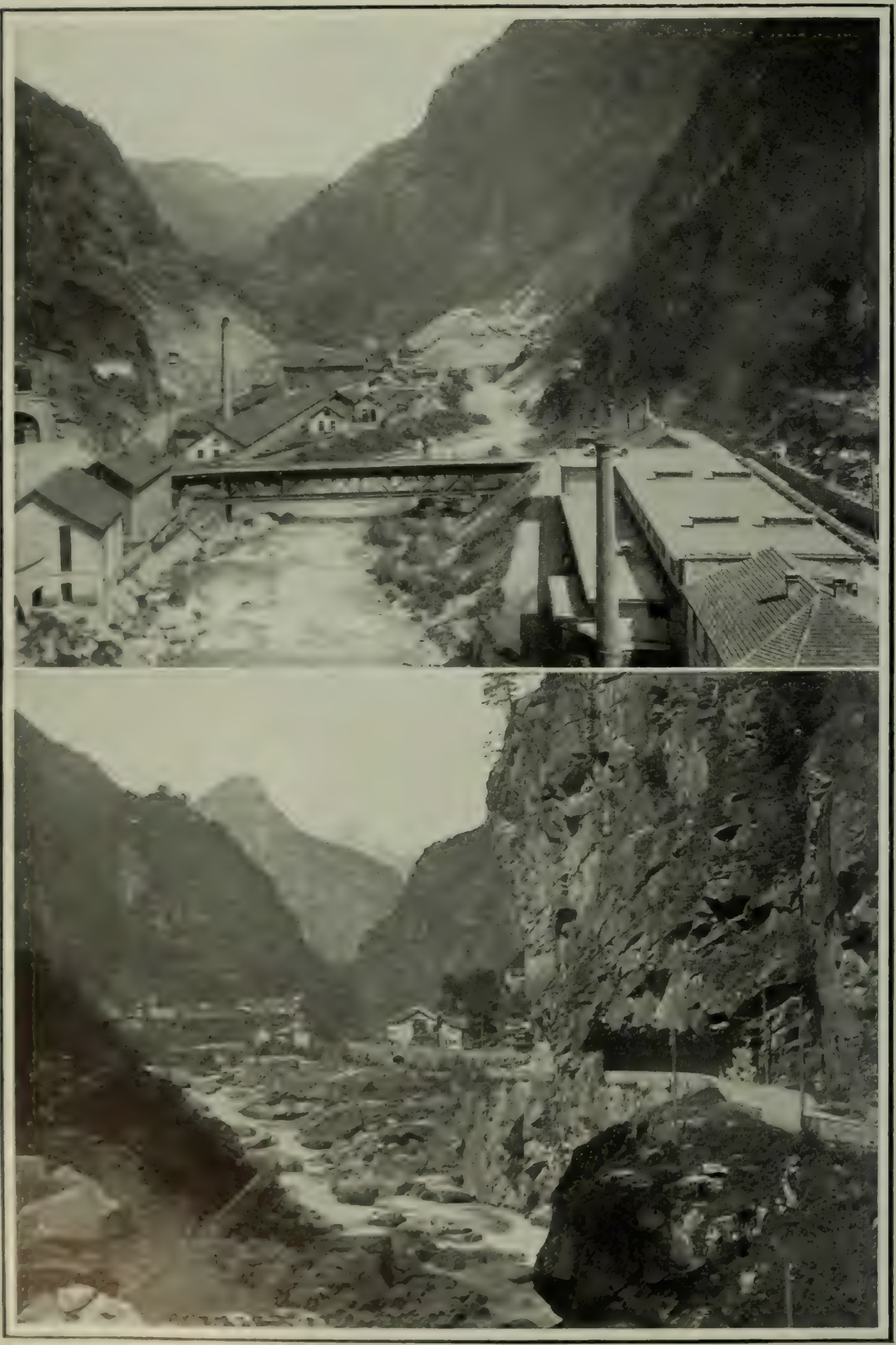
The lower view shows the village, and the upper one the shops, store houses, and installation in general for the tunnel work.

opening was enlarged and the water drained off by piping, which had already been prepared for this event. It took only a few hours to drain off the reservoir, and now the work is being continued until the tunnel will have its standard size clear up to the end of the Swiss side, which had been abandoned. It then will remain to complete the masonry of the tunnel, and afterwards to lay the track for the electric trains, which are to be used here. This will take several months, and it is expected that the inaugural opening of the tunnel will come during the fall. This makes nearly seven years from the starting of the tunnel until the moment when the trains will be running from Brigue to Domo d'Ossola, and the work will have cost something like $16,000,000.

The installations at the ends of the tunnel at Brigue and Iselle, which will be observed in the engravings, give an idea of the extent of the work. At each end, the offices and shops cover an area of 7,000 square yards, including engineers' offices, engine and turbine plants, dynamos, forges, repair shops, locomotive houses, stables for the horses, storehouses of all kinds, for lime, cement, iron, dynamite, and the observatories for the surveying of the tunnel. At the two ends veritable villages were built to accommodate the thousands of workmen employed in the tunnel and shops. Two turbine plants were erected, on the Rhone for the north side, and on the Diveria for the south, to obtain the 2,400 horse power which was needed for the drills, the lighting, and the twenty-five trains per day for workmen and materials. To ventilate the tunnel and lower the rock temperature, which sometimes reached 132 degrees F., a system of powerful fans sent from 50 to 60 million cubic feet of cold air to the end of the tunnel per 24 hours.

During the five years of work in the tunnel, the operations were carried on continuously day and night without stopping except to verify the alignment of the tunnel. The gangs of workmen took eight-hour turns, and in the more difficult places this was reduced to six hours. When the attack advanced at the same time in the two galleries and in a good rock, the rate of working was from 15 to 30 feet per 24 hours, or some 6 feet for each explosion of dynamite, in a gallery 6 feet high and 10 feet wide. The consumption of dynamite reached half-a-ton per day.

The main difficulties on the Italian side lay in the hardness of the rock in some places, and again in a soft and yielding rock which threatened to crush all the vaulting that could be constructed. The action of the drills upon the granite of the region had been observed

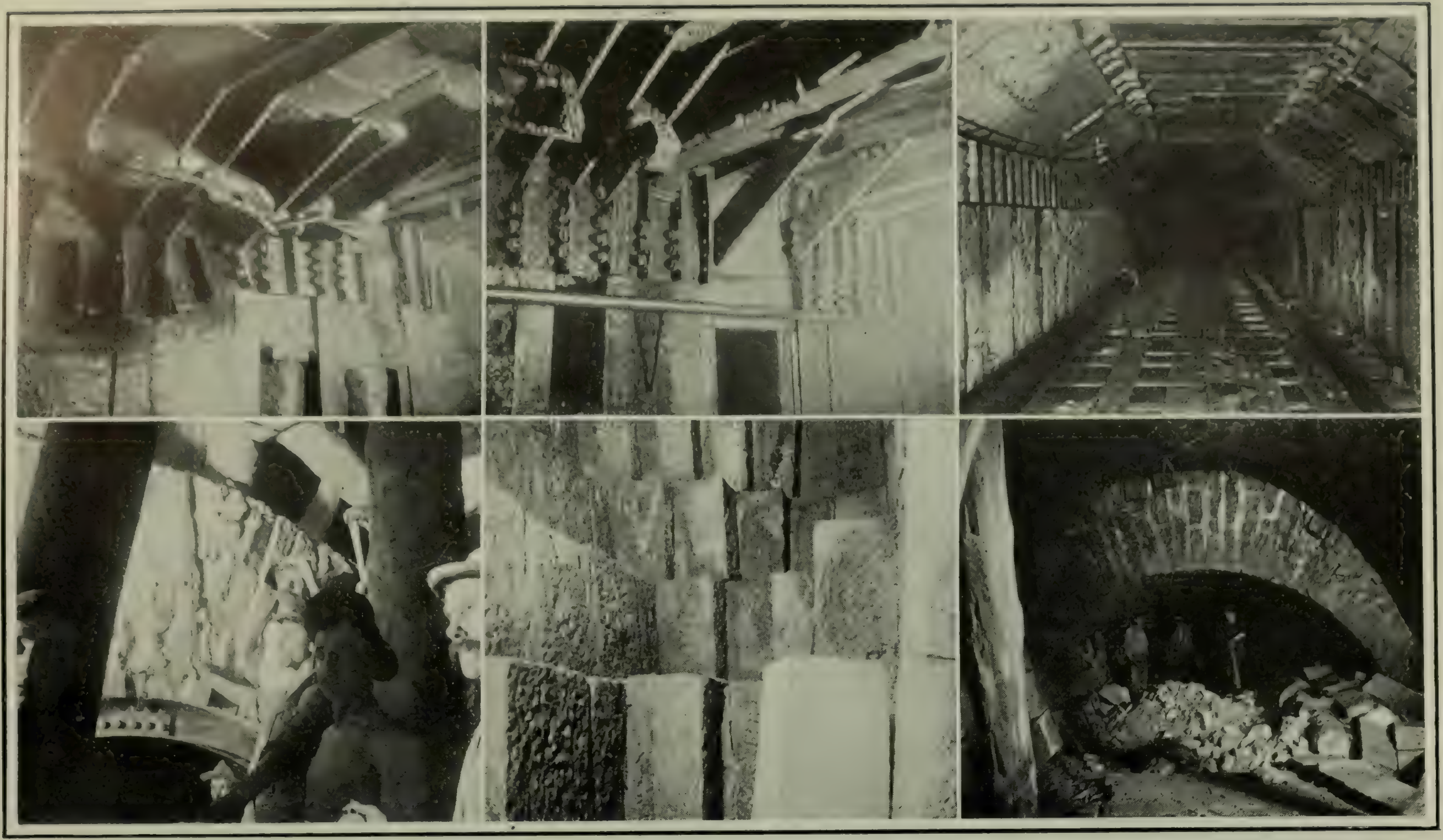


ISELLE, AT THE ITALIAN PORTAL OF THE TUNNEL.

The lower picture shows the village; the upper, the tunnel installation. The railway formerly terminated at Domo d'Ossola, but was extended up to Iselle to complete the tunnel route.

in the open air and upon blocks taken from the mountain and submitted only to atmospheric pressure. But when the drills met with the granite under much greater pressure, due to the layers of the mountain overhead, they could not attack the rock which had thus been made more compact except by using a higher hydraulic pressure and a longer working period. The enlargement of the tunnel section by the pick also suffered a like delay owing to the hardness of the rock. This will be noted when it is stated that during the whole of the passage through the granite, the shops were obliged to re-forge and re-temper as many as 13,000 mine chisels per 24 hours. As the gallery is formed, the walls are freed from the counter-pressure of the interior. This brings about an extraordinary effect. Under the concentric pressure the rock splits off with a deafening noise and the debris is shot for several yards. A workman was killed by being struck with one of these flying pieces. This very strange phenomenon caused much fright and perplexity at first, and it took some time to become accustomed to it.

After passing the granite the workmen came upon a region of bad rock which caused even greater difficulties. In the first place, after going through the solid rock, they met with a hot spring of 90 degrees F. at the 2.4 mile point. Then at the 2.6 mile point they found cold springs. The work had to be stopped until the water could be taken off by a system of piping. Then they proceeded cautiously and by hand, and soon reached a point which gave them a great deal of trouble. On November 5, 1901, at the 2.8 mile point, the drills penetrated into a rock which was found to be very soft, and this event was unforeseen. Solid timbering was built to uphold the roof, as usual, and the work proceeded. But before 50 feet had been passed, it was found that the rock was sinking, and it caused an almost irresistible pressure upon the timbers, distorting them and threatening to break them in fragments. Fortunately this action was slow, but some measure had to be taken at once. To resist the pressure, a series of heavy frames built of 16-inch channel bars, capable of supporting 100,000 tons, were set up and reinforced by heavy beams. The frames, spaced 6 feet apart, served to uphold the roof, and 74 of them were used here. Even this construction was not strong enough, and it had to be reinforced by new pieces. The iron was bent and twisted under the pressure of the mountain. This new framework, however, was only temporary. It formed an armored passage through which passed all the material needed for the advancement of 2 miles of tunnel in the space of two years, without

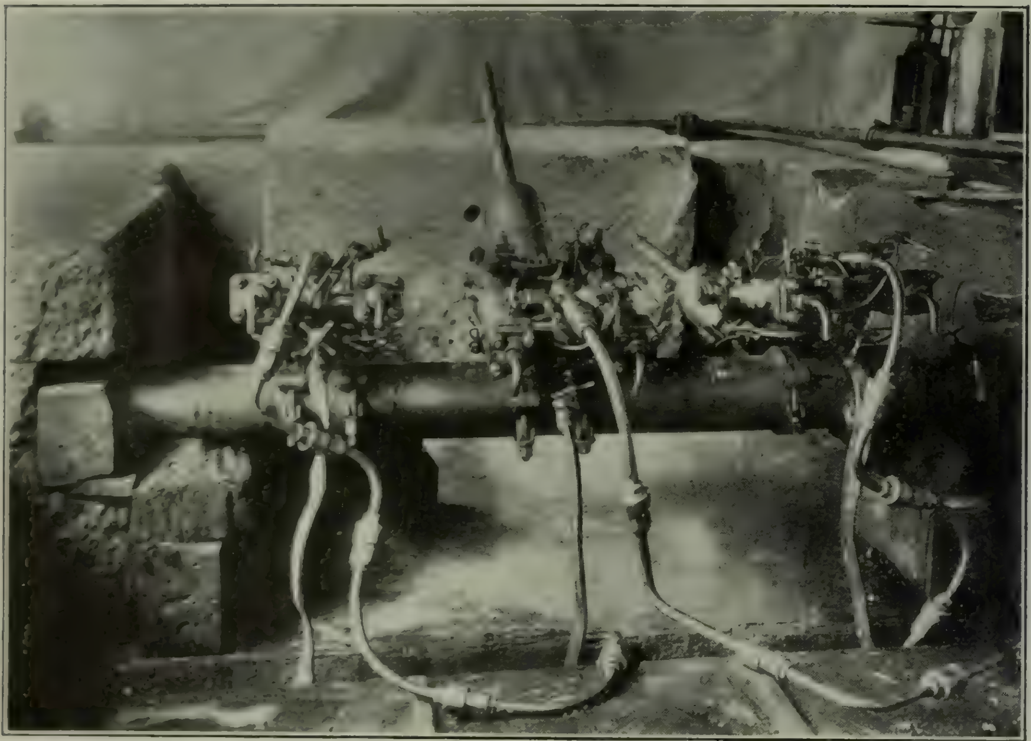


FEATURES OF THE WORK IN THE "ZONE OF COMPRESSION" ENCOUNTERED IN THE SIMPLON TUNNEL.

Reading from left to right, the small illustrations show:—In the top row, 1, the effect of the rock pressure on the tunnel lining; 2, the heavy steel lining first put in; 3, lining consisting of iron frames with concrete filling; cold water conduit on the left. In the lower row; 4, first heading for the permanent lining; 5, keying of the permanent arch (looking upward); 6, masonry centering of the permanent arch.

interruption, including six trains of workmen per 24 hours, trains of debris, wood, tools, masonry and cement. But this roofing had to be replaced by a permanent construction having the standard section of the tunnel. This took 18 months and required an extraordinary work. It was carried out as follows:—

In the narrow intervals between the frames, the workmen made a series of lateral niches, on one side only, which were just large enough to stand in. Then with great difficulty they dug beneath their feet a series of pits about 10 feet deep. For every cubic foot taken out they had to brace the sides very strongly with beams and plates, to resist the pressure of the mountain. From the bottom of these pits, using the same precaution, the miners arrived under the frames and dug out spaces 8 feet long and 2 feet wide, or in the direction of the tunnel. After this work had been carried out inch by inch, one may say, the miners gave place to the masons who were chosen among the most expert. In the chambers which were thus formed they built a foundation of well-cut stone and cement, which filled up the space. This made a continuous foundation floor for the tunnel, as a similar work had been carried out meanwhile from the other side, and the remaining spaces were filled up by masonry. The foundation was perfectly homogeneous and solid. It then remained to build the side walls and the vaulting, but this could not be done at once, on account of the enormous pressures. They decided to surround the armored vault by masonry covering which should be temporary and give a support for the permanent vaulting. This was done by building up very solid pillars in the niches already mentioned and upon them was placed an arch in channel iron resting on the tops of the pillars. Above the arches was laid a masonry vaulting formed of granite and first quality of cement. These pillars and arches, having some 3 feet width, were separated by 2½ foot spaces, but a set of beams connected them across. Thus the 140 feet of gallery at this point was upheld by 25 solid arches. The iron frames, which had arrived at the limit of resistance and were bent and twisted, were removed. In some places they had left but an inch above the traveling carts. It then remained to build the permanent uprights and vaulting. The side wall was built in sections which were then joined together, and is more than 10 feet in thickness. For the vaulting, they superposed four ranges of concentric voussoirs, the inner of which rested upon the temporary vaulting. The space between the outer arch and the rock was filled up with cemented masonry. The inner and temporary vaulting was then removed by dynamite. At present the base,



BRANDT DRILLING MACHINES, USED IN DRIVING THE TUNNEL.

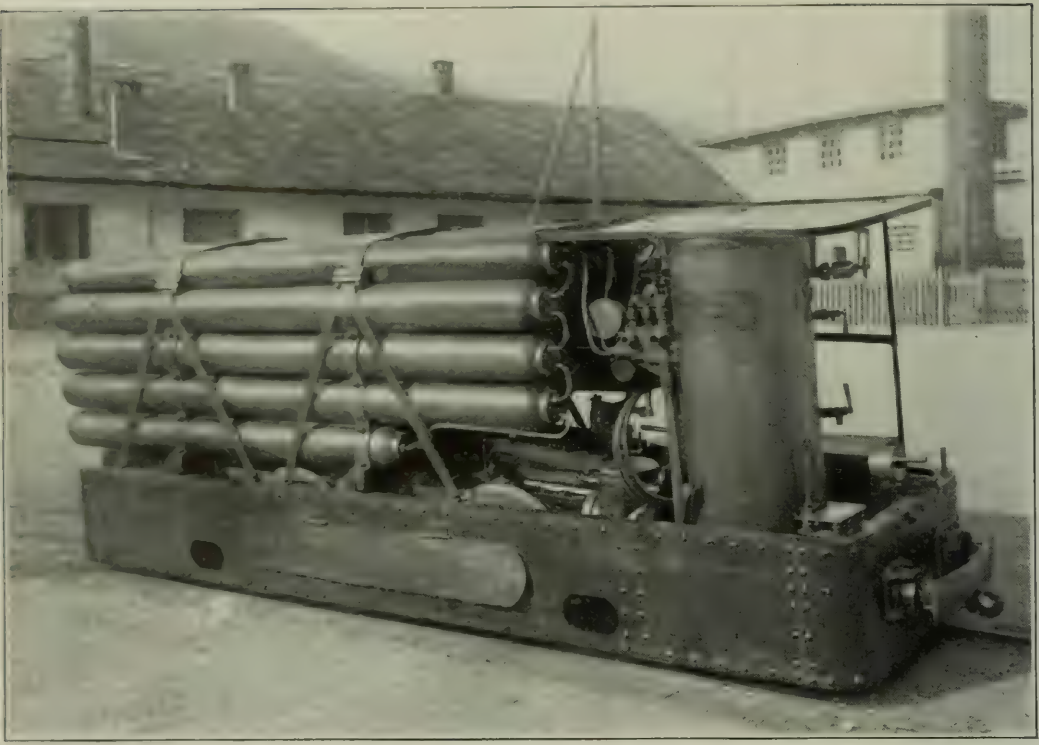
the wall, and vaulting form a solid canal, which is able to resist the immense pressure exerted upon it from all sides. In fact, it has shown no movement, and this work, although it is buried in the depths of the earth, is one of the most admirable examples of the engineer's art. The figures will give an idea of this undertaking, when we find that it cost $5,000 per running yard, and this with European labor. Few of the passengers who travel through the tunnel will think of the work which was required to retain the pressure of the mountain at this point.

On September 6 of last year the drills opened a spring of 20 gallons per second at the 5.5 mile point of the tunnel on the Italian side. The water had a temperature of 111 degrees F., and the work had to be abandoned at once. As the rock had been very dry up to this point, nothing indicated that they would receive such a shower-bath. The water flowed along the tunnel for some 2,000 feet, where it found a passage into the side gallery and ran into a sewer which led from there. The first thing was to continue the sewer in haste as far as the source of the spring and thus take off the water by the side gallery, clearing the main tunnel. This canal was entirely covered to keep in the heat and allow the men to work. The next operation was to push the side gallery, since they could not go ahead with the tunnel. They would finally reach the spring from here also, but in this case they were prepared to take off the water in wood conduits to prevent heating. As soon as it appeared, the water was easily led off by the conduit. When the critical point was passed by the advance of the gallery, they cut through to the axis of the main tunnel by a cross passage, and were now 100 feet ahead of the end of the tunnel. From here they went on with the main tunnel to the north, and at the same time turned back to the south and took down the short piece of 100 feet in the rear so as to reach the main tunnel. This last operation was carried out in December and January last.

The work of installation commenced on August 6, 1898, at Iselle, and on August 16 at Brigue. The mechanical drilling commenced on the north side November 22 and on the south end one month later.

As to the main railroad lines which connect the Simplon route, it may be mentioned that the Italian Government, which controls the railroads on that side, has neglected nothing to secure a good connection for through trains coming from the north, and has laid out 15 millions already for this purpose. The Simplon is connected with Milan by the Arona-Domo d'Ossola branch, and with Turin by the Borgomanero line. On the northern side France has done nothing as yet to further the international through traffic. This is owing to

AIR-COMPRESSOR INSTALLATION FOR THE TUNNEL, BRIGUE.



A COMPRESSED-AIR LOCOMOTIVE USED IN THE SIMPLON TUNNEL WORK.

the fact that a number of different projects have been proposed, and these have conflicting interests, so that after considerable discussion, nothing definite has been decided upon as yet.

At present the distance between Calais and Milan is 1,147 kilometers (712 miles). It will be 1,131 kilometers (703 miles) by the Simplon route. The distance from Paris to Milan, which is 893 kilometers (556 miles) by the St. Gothard route, will be shortened to 883 kilometers (517 miles), using the proposed Mont d'Or straight cut in France. The rapid express trains will run from Lausanne to Milan in 5½ hours, and from Paris to Lausanne in 9 hours, when the La Joux-Vallorbe line is constructed. However, the railroad lines which now exist between France and the Simplon are not adapted for rapid international traffic over the whole distance.

TABLE OF COMPARATIVE DATA OF SEVERAL GREAT TUNNELS.

	Mt. Cenis.	St. Gothard.	Arlberg.	Simplon.
Length of the tunnel.............	7.9 miles	9.25 miles	6.38 miles	11.9 miles
Maximum altitude	4219 feet	3755 feet	3260 feet	2290 feet
Heaviest grade, per cent........	2.2	2.7	1.5	0.7
Height of the mountain above the tunnel	5390 feet	5544 feet	2340 feet	6840 feet
Maximum temperature, degrees F.	84 deg.	86 deg.	64½ deg.	104 deg.
Mean daily rate of advancement..	5.1 feet	9.7 feet	15.7 feet	16-18 feet
Duration of the work...........	13 years	9 years	4 years	7 years
Cost per running yard..........	$1075	$700	$625	$770

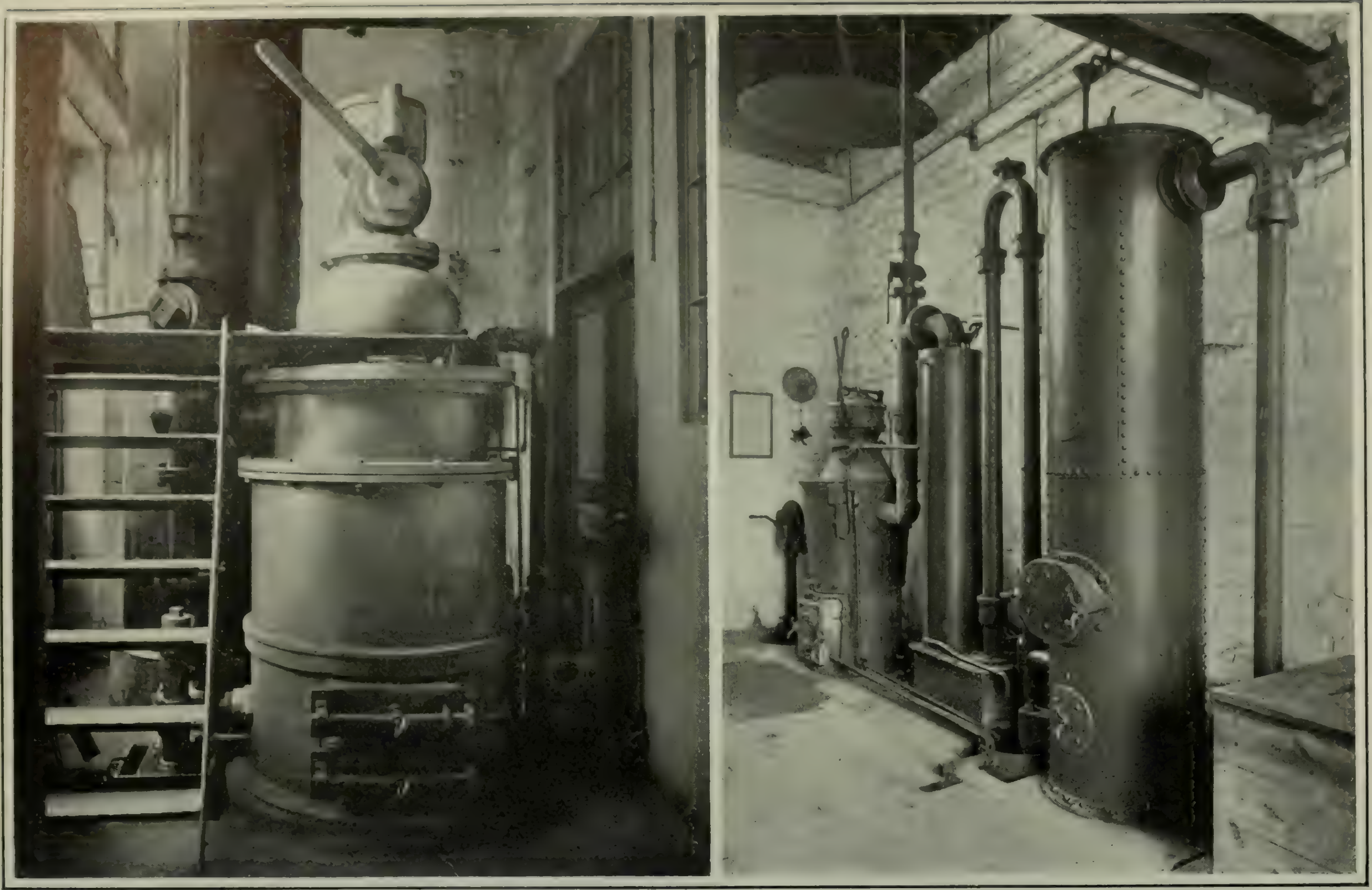
THE DESIGN AND OPERATION OF THE SUCTION GAS PRODUCER.

By Rodolphe Mathot.

While much attention has been directed of late to the development of the large gas engine, there has at the same time been in progress an important advance in the design and operation of moderate-sized gas-power plants. By the rapid introduction of the suction gas producer, operated in connection with the ordinary gas engine, it has been made possible to generate power in small units at a cost hitherto attainable only with the largest and most complete power stations. Mr. Mathot is recognized as one of the ablest experts on the Continent in the special department of the design of gas-power plants, and in this paper he gives the results of the latest experience as it affects the proportions and operation of such plants; to which a brief description of the general arrangement of a suction plant has been prefixed. In a succeeding article Mr. Mathot will discuss the principal features in the latest improved gas engines which aid in enabling the suction plant to compete successfully with the highest types of steam engines.—The Editors.

THE early gas engines were designed for the use of illuminating gas, but the high cost of this fuel has led to the design of various forms of apparatus for the production of a cheaper fuel. Among these the best success has been had with various forms of gas producers, supplying what has been generally termed "producer" gas, of which the combustible portion consists mainly of carbon monoxide. In general, such producers consist of a generator, usually cylindrical in form, and of sufficient height to contain a deep bed of fuel. The lower portion of the fuel bed, resting on a grate, is raised to incandescence by a blast of air supplied either by a fan or by a steam jet, the result being a combustion of a portion of the coal to carbon dioxide, and this passing through the upper portion the heated coal becomes largely converted into carbon monoxide. Any steam which is delivered below the grate becomes dissociated in passing through the incandescent coal bed, the hydrogen enriching the gas, and the oxygen combining with the carbon to form carbon dioxide, afterwards partly converted into carbon monoxide, the final product being what is termed semi-water-gas.

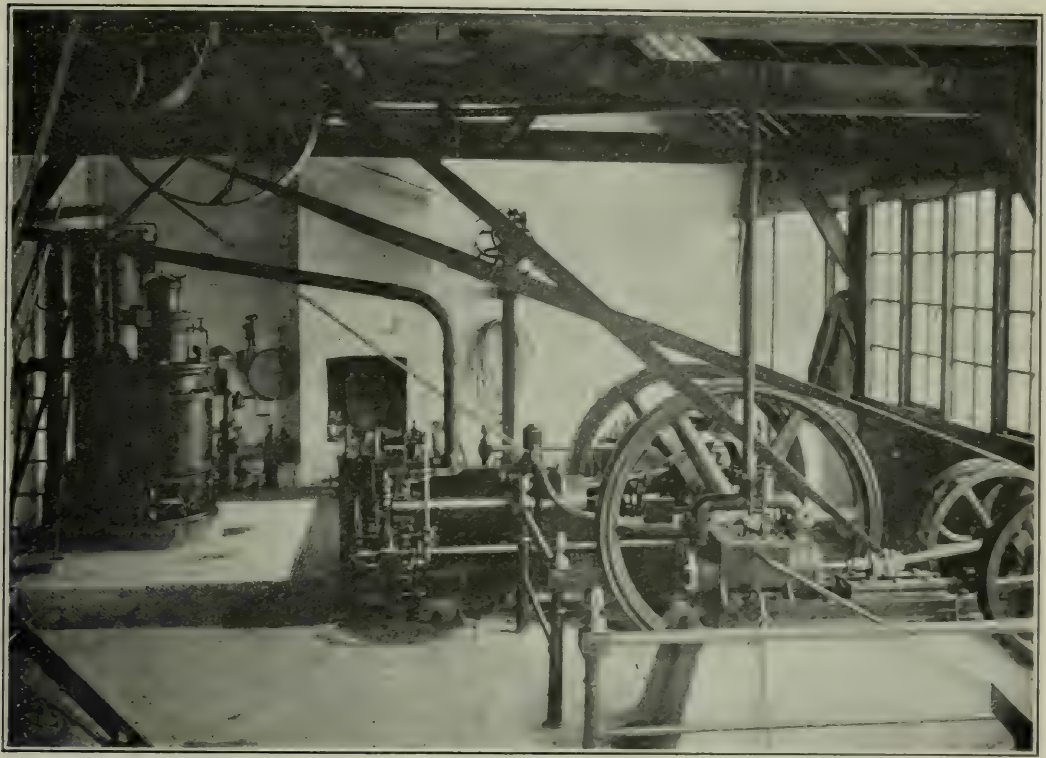
The principal practical difficulties which have been encountered in using producers of this type have been of a mechanical character. A separate steam boiler is necessary to operate the steam jet, and the fact that there is a pressure beneath the grate makes it necessary to have some form of water seal, or tight joint at the bottom, while



TYPES OF SUCTION PRODUCER APPARATUS IN ACTUAL INSTALLATION.

On the left is a 60-horse-power Otto suction producer. On the right, a 25-horse-power Dowson suction plant and National gas engine **at** Althorp Park, the residence of Earl Spencer. It is used for electric lighting.

the entire apparatus also has to be made gas tight. Since the production of gas is independent of the operation of the gas engine to which it is supplied, it is necessary also to provide a gas holder, to act as a storage reservoir, so that the whole plant is more or less cumbersome and requires a certain amount of skilled attention.



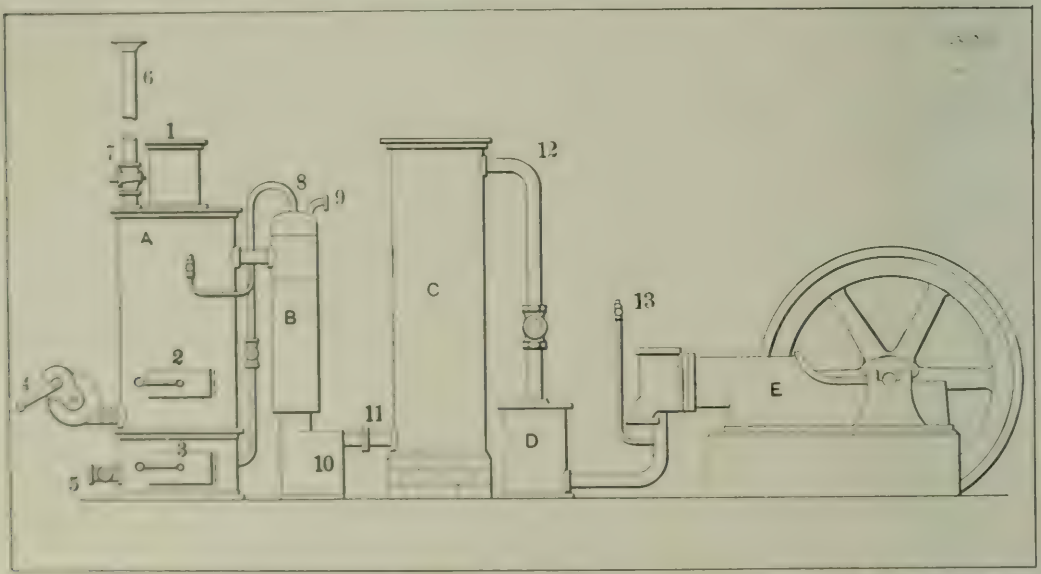
GAS ENGINE AND SUCTION PRODUCER DRIVING STONE-DRESSING MACHINERY.
Generator 74 in. high over all; scrubber, 85 in.; engine, 35 indicated horse-power, 180 revolutions. Installed by Tangyes, Ltd., Birmingham.

In the modern internal-combustion engine, whether of the four-cycle or the two-cycle type, one of the outward strokes in the cycle is a suction stroke, and this suction is always employed to draw in the mixed charge of gas and air. Instead of allowing this suction to draw the gas merely from a holder or main, it has been suggested to connect the engine directly to the upper part of the producer, and thus utilize the suction of the engine to draw the air through the coal bed, instead of impelling it by pressure. This is the fundamental idea of the suction gas producer, a device which bids fair to extend the use of the complete gas-power plant to a much wider field than has hitherto been possible.

Apart from the dispensing with the separate blowing jet, the substitution of suction for pressure causes a pressure slightly below that of the atmosphere to be maintained in the whole apparatus, so that there can be no leaks of gas, and there is no necessity of sealing the ash pit. As no steam under pressure is required, the separately-fired boiler is replaced by what is termed a vaporizer, this consisting of a vessel containing water, raised by the heat of the gas to a temperature nearly as high as the boiling point, the vapor thus formed being delivered under the grate and drawn through the coal bed, with the air, by the suction of the engine. Since the rate of the production of the gas depends upon the suction action of the engine, the supply is automatically controlled by the demand, the production of gas ceasing when the engine is stopped, and increasing if the speed of the engine is increased. There is therefore no necessity for a gas holder, and no gas is stored at any time beyond that which is contained in the pipes and passages of the apparatus.

It will be seen that the substitution of suction for pressure has thus simplified the apparatus by dispensing with the steam boiler, and with the gas holder, and has also done away with the operative difficulties involved in a sealed ash pit, while at the same time it introduces the advantages of an automatic regulation without the employment of a single piece of additional apparatus.

The general construction of a suction-producer plant will be obtained from the following illustration:—

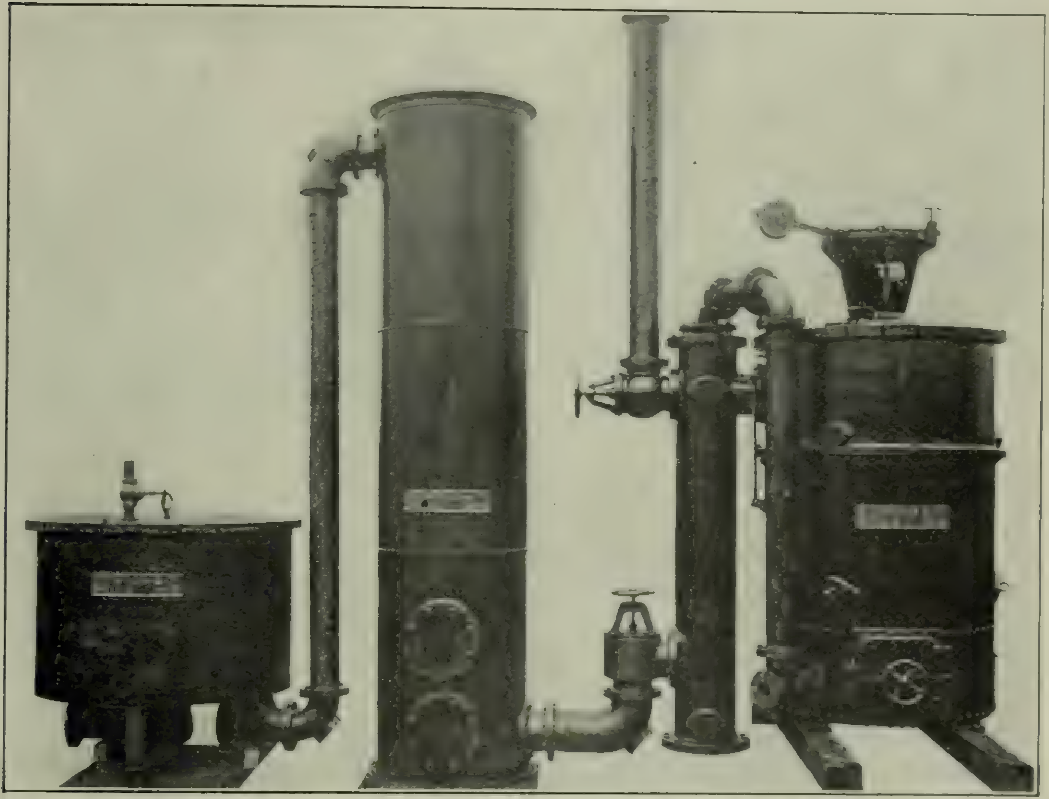


The Engineering Magazine

GENERAL ARRANGEMENT OF A SUCTION PRODUCER PLANT.

A, producer; B, evaporator; C, scrubber; D, pressure equalizer; E, gas engine. 1, coal hopper with gas lock; 2, cleaning door; 3, ash-pit door; 4, hand blower, for starting; 5, air valve; 6, escape pipe; 7, outlet valve—these for use when the gas engine is not running. 8, pipe conveying steam from vaporizer to ash pit; 9, air inlet to vaporizer; 10, water box; 11, gas connection to scrubber; 12, gas outlet from scrubber; 13, test valve for sampling gas at engine.

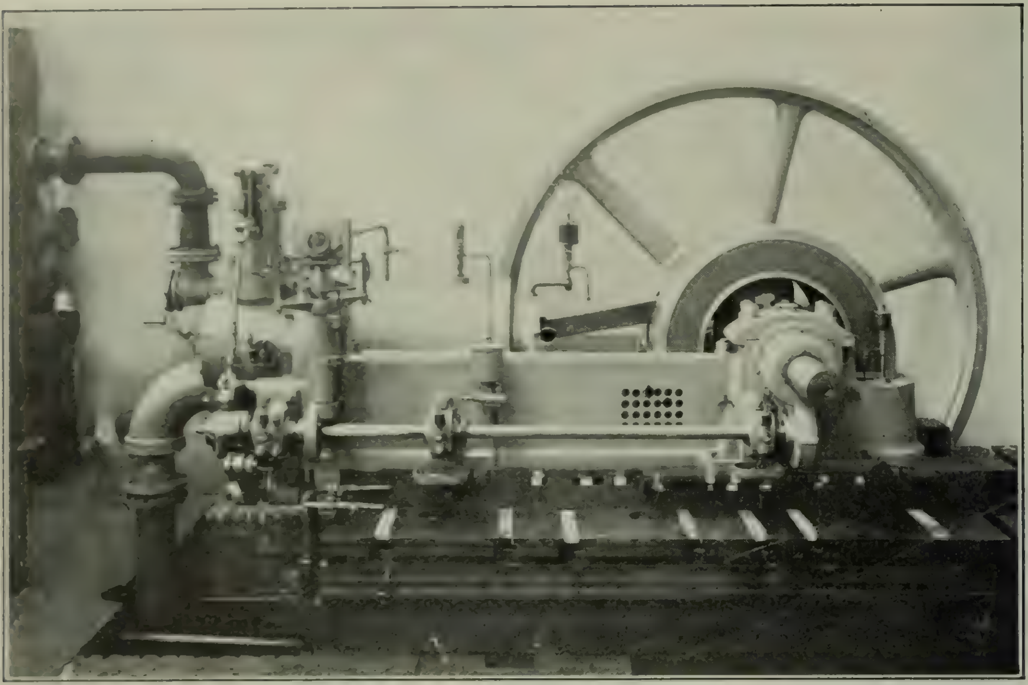
The introduction of the suction producer appears to have given a fresh impetus to the development of internal-combustion motors operating with lean gas. It will therefore be of interest to consider the desirable features involved in the design of these gas-producers and the motors to be used with them, in order to secure a satisfactory and regular operation.



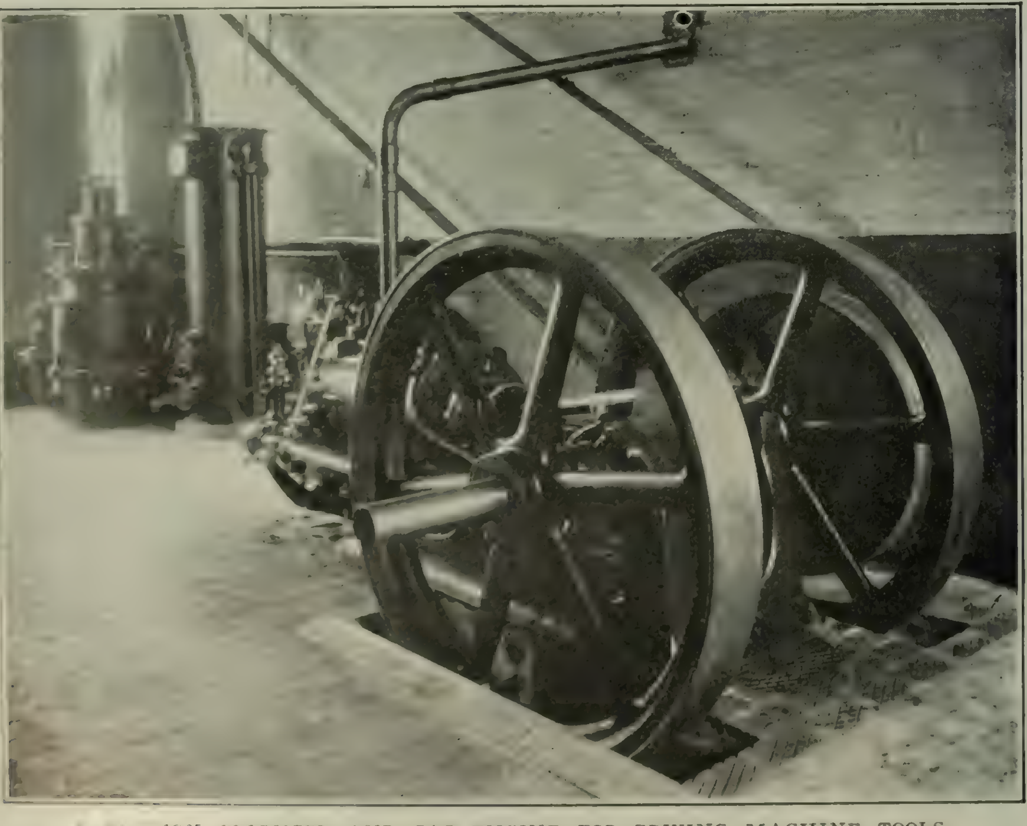
SEVENTY-FIVE HORSE-POWER SUCTION-PRODUCER PLANT.
R. D. Wood & Co., Phila., Pa.

So far as the gas producer itself is concerned, it is now four or five years since the principle of utilizing the suction produced by the engine as an effective substitute for the blast of a jet or fan blower has been successfully applied in working apparatus. Although the subject is therefore still a novelty, certain principles have already developed, from practice rather than from theory, by means of which the best results may be obtained in the use of suction devices for generating lean gas.

At first the designers of such apparatus, probably guided by the experience obtained in steam-boiler practice, tended to construct producers of too large dimensions, especially in regard to the dimensions of the retort, or producer proper. The result of this practice was the production of an abundant volume of gas, but of a very poor quality because the temperature of combustion was kept too low.

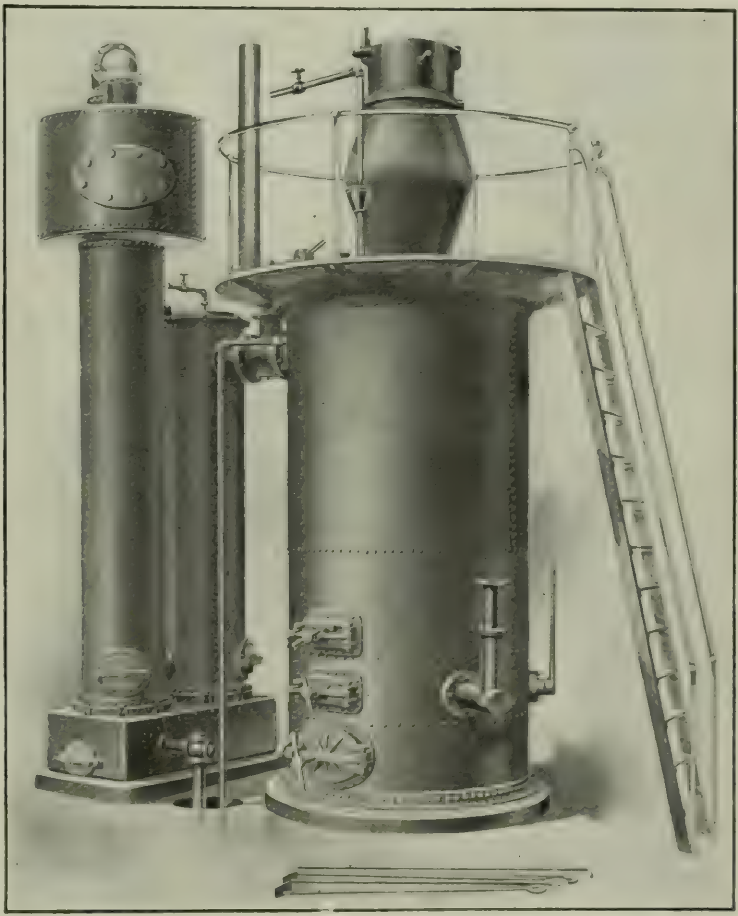


SIXTY-HORSE-POWER OTTO SUCTION GAS PRODUCER AND GAS ENGINE.
Gas Motoren Fabrik Deutz.



A SUCTION PRODUCER AND GAS ENGINE FOR DRIVING MACHINE TOOLS.
Over-all height of generator, 74 in.; of scrubber, 97 in.; engine, 47 indicated and 39 effective horse-power, 180 revolutions. Supplied to Swift Cycle Co., Coventry, by Tangyes, Ltd., Birmingham.

The fact must always be borne in mind that the principal element which enriches the gas is the hydrogen resulting from the dissociation of the water, contained in the state of vapor in the air by which the furnace is fed. The draft, or supply of air, induced by the motor, is a function of the dimensions of the machine, while the velocity of the air current becomes greater as the area of the grate is reduced. It is this velocity of the air which augments the activity of the fire, and renders possible the dissociation of the maximum quantity of water.

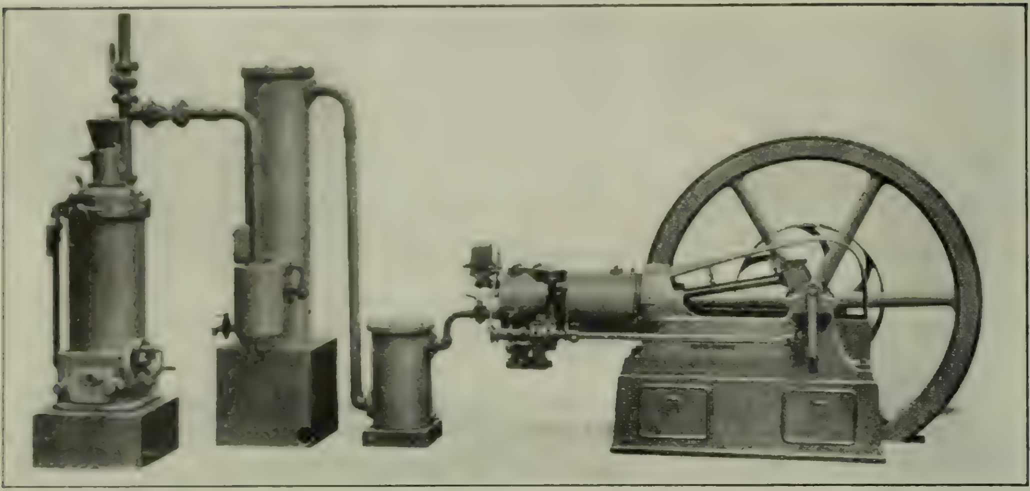


AMERICAN CROSSLEY SUCTION GAS PRODUCER.

Built by the Power & Mining Machinery Co.

Experience has demonstrated that the cross section of the base of the producer which gives the greatest production of hydrogen and the most effective reduction of carbon dioxide to carbon monoxide, varies between 0.6 and 0.9 times the area of the piston of the engine producing the suction. This rule applies to the simple four-cycle gas engine, running at a linear piston speed of 600 to 800 feet per minute. The depth of combustible contained in the upper part of the producer retort should be from two to five times the diameter of the base, for lean coals in sizes from ½- to ¾-inch lumps.

The above proportions, when the apparatus is properly arranged and fed, have been shown in practice to be well adapted to provide a combustion zone and a reduction zone of the proper thicknesses to transform continuously the maximum proportion of vapor of water

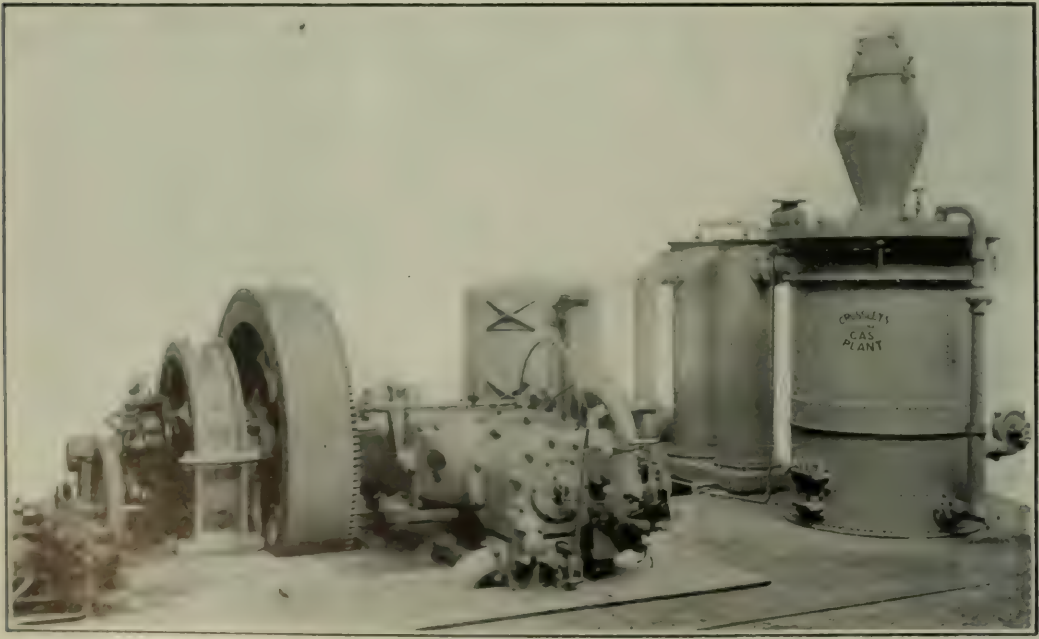


A 12-HORSE-POWER SUCTION-GAS-PRODUCER INSTALLATION.
Maschinen fabrik Kappel, Chemnitz-Kappel.

and to reduce the corresponding proportion of carbon dioxide. The quantity of water dissociated varies from 0.8 to 1.2 times the weight of lean coal consumed.

An examination of more than a score of chemical analyses of the gas produced by various systems of suction gas-producers gives the following average composition:—

Carbon monoxide	24 per cent.
Carbon dioxide	5 " "
Hydrogen	17 " "
Nitrogen	54 " "



EIGHTY-HORSE-POWER GAS ENGINE AND SUCTION GAS PRODUCER, FOR CALCUTTA ELECTRIC SUPPLY CORPORATION.
Fuel consumption 0.92 lb. coke per brake-horse-power hour. Crossley Bros., Ltd., Openshaw, Manchester.

Methane appeared in traces only, since these installations were operated with anthracite coal. The calorific power of the gas ranged from 135 to 150 British thermal units per cubic foot, varying according to the composition of the fuel, the average constitution of the coal being:—

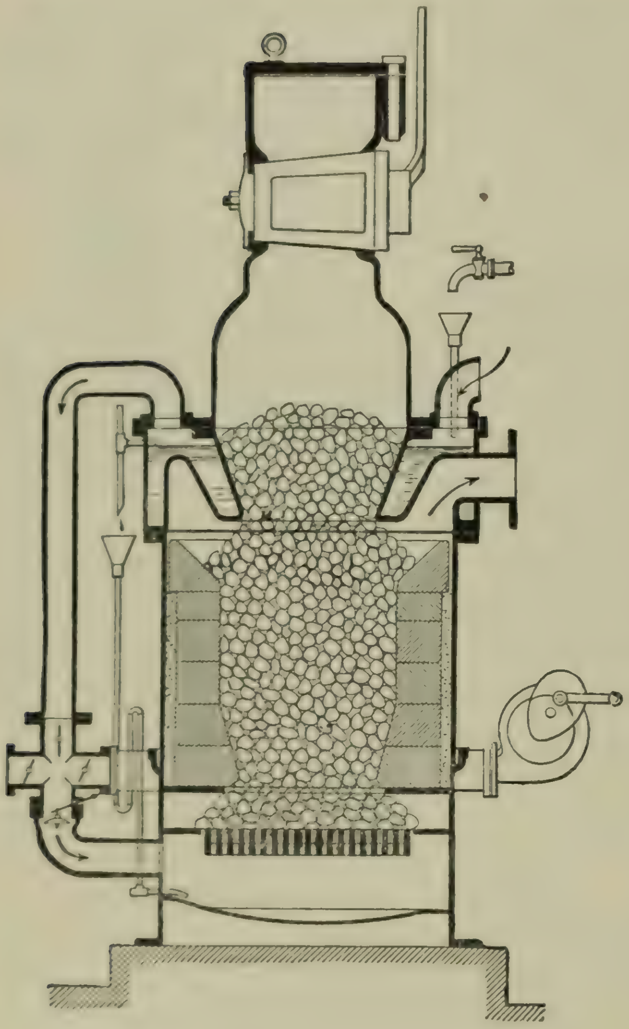
Carbon	89 per cent.
Hydrogen	2 " "
Oxygen and nitrogen	4 " "
Ash	5 " "

the calorific value ranging from 13,500 to 14,400 British thermal units per pound.

On the Continent it is impracticable to obtain pure anthracites such as are found in Wales or in Pennsylvania, and it is necessary to use lean coals, such as can be found in many localities, and are well adapted for use in the suction producer. In selecting a fuel for use in the suction producer certain requirements should be observed. So far as dimensions are concerned, the lumps should range from ½ to 1¼ inches in diameter, this being a commercial sizing which is not so small as to obstruct the passage of the gas in its formation. It should be as free from dust as possible, and contain not more than 8 to 10 per cent. of ash in order that the grate may not be obstructed. The maximum permissible proportion of volatile matter is from 8 to 10 per cent., and the coal should have no tendency to swell or to coke during the combustion; otherwise pockets or arches will be formed, acting to impede the natural descent of the fuel in the producer. In order further to prevent this danger, the producer must be provided with poking or barring holes to enable the fire to be stirred and agitated without admitting air or causing an excessive fall of cinders into the ash pit.

Coals which produce much tar should be avoided, as well as those containing sulphur. The deposit of tar in the pipes, and especially about the valves, is one of the principal causes of unsatisfactory action; while the presence of sulphur, in connection with the brief washing given to the gas, and without chemical purification, causes the production of sulphuric acid, with consequent corrosion of the working metallic parts.

If an excess of air enters the producer through the grate it interferes with the distillation of gas by cooling the zone of combustion, and the dissociation of the steam is checked. If air enters through the charging opening, above the fuel, it dilutes the gas, and may produce dangerous explosive mixtures. It is therefore important



SECTION OF A SUCTION PRODUCER.
Otto-Deutz.

that all parts of the apparatus, including the producer, vaporizer, scrubber, etc., should be tightly closed. In those forms of producers in which the excess of water from the vaporizer is allowed to collect in the ash pan, a sudden fall of incandescent cinders, due to an excessive poking of the fire, may produce an excess of steam, causing a sudden disengagement of water gas. This may be followed by serious shocks in the engine, caused by violent explosions or premature ignition. Generators with a water pan in the ash pit are, however, well adapted for a proper production of vapor, especially if the air supply is previously heated before its delivery to the ash pit. At the present time, however, preference is given to producers equipped with the internally heated vaporizer, although these generally require more time to heat up the water to a temperature of 175 degrees to 200 degrees F., at which an ample supply of vapor is given off.

Externally-fired vaporizers, constructed with tubes or small sections, offer a large amount of heating surface, with thin walls well adapted for the transmission of the heat in the gas to the water to be vaporized. Such vaporizers will produce sufficient vapor to enrich the gas in from 10 to 13 minutes after starting the fire in the producer. With a well-designed tubular vaporizer the producer and motor should be in action at full power in 20 to 25 minutes after lighting up. The principal objection to the use of tubular vaporizers is found in the difficulty of cleaning the surfaces from ashes and tarry deposits, and in removing the scale which forms in the tubes. The presence of ammonia or sulphur also tends to corrode the tubes, and for this reason tubes of brass or copper should not be used.

It is a good plan to have the outlet pipe for the gas, after it has passed through the vaporizer, and is therefore partially cooled, arranged to be submerged about an inch below the surface of the water in the base of the vaporizer. This forms a sort of hydraulic seal, and helps to remove any fine dust which may be carried along with the gas.

The scrubber, in accordance with good practice, is made six to eight times the volume of the producer, the height being three to four times its diameter. The best filling for the scrubber is metallurgical coke, in lumps of three to four inches in diameter, the upper fourth of the scrubber being filled with smaller pieces, of about half this size. The quantity of water required for the washing of the gas varies from three to five gallons per hore power hour, when the fuel is anthracite, such as referred to above. In order to prevent the entrainment of water and consequent injury to the engine, a screen or partition should be arranged at the outlet of the scrubber, to prevent water from being carried over with the gas. All elbows and angles in the pipes should also be provided with removable covers, in order that the pipes may be readily and completely accessible for cleaning.

These are the general principles which should govern the design and operation of modern suction gas producers, and apply equally well to those intended to supply motors of 10 horse power as well as those of 150 to 200 horse power. Tests made by the author upon a small suction producer and engine plant by Körting, of only 6 horse power, gave a gross fuel consumption of 1.126 pounds of anthracite per effective horse-power hour. Very complete tests made by the author, in connection with Professor Aimé Witz, upon a double-acting Otto-Deutz engine and a producer of 200 horse power, gave the remarkably low consumption of 0.722 pounds of coal per effective horse power hour. This result was obtained in a test of ten hours duration, in the ordinary course of operation of the plant.

THE STORES SYSTEM OF THE NATIONAL-ACME MANUFACTURING COMPANY.

By A. W. Henn.

This is the second of a group of special articles announced for publication in this Magazine, dealing with successful stores systems in actual use. The purpose in each case is to present the entirety of a working system, with all the forms filled as in regular use, and the applications described by the official in immediate charge. Mr. Henn is the secretary of the National-Acme Co. The company manufacture automatic screw machines and their product.—The Editors.

IT has been aptly said that "the best system which can be devised for any particular shop is that which is best adapted to its individual requirements." No two concerns, it may safely be assumed, would find it equally advantageous to adopt identical forms and methods; hence those referred to in this article are presented simply as the best or most suitable from experience to date for "individual requirements." Little attempt has been made at, and less claim is laid to, originality; selection has been chiefly from articles pertaining to stores-room methods and practices that have appeared in trade papers and industrial journals. Of necessity, all borrowed forms were more or less modified to suit the needs of a "particular shop." All systems have a common aim, and the superiority of one over another lies but in the routine manner of securing the desired information, a prime requisite of any system being results with a minimum of friction and expense. The duties of each one working under the system adopted should be clearly defined, general instructions preferably being given in brief and concise written form; no conflict of authority or misunderstanding among subordinates should be allowed to serve as a reason or excuse for in any manner holding up work or staying the progress of an order.

Contemplating for a moment the requirements for which provision as to stores had to be made in the business considered in this article, we find the manufacturing end logically divided into two departments, one styled Machinery and the other Product. Book accounts for each are kept so far as practicable as though they were for independent concerns. The chief items of raw material consumed in the former are castings and bar steel; in the latter, brass, iron, and steel rods. Of castings and heavy steel for account of the

Machinery department, sufficient are consumed and carried to warrant their being treated as a separate division; the same applies to rods stocked solely for product-department account. All other material is handled through the factory stores room and referred to as small stores. There are then three separate sources of supply:—

I.—Small stores (termed "stores"); for general distribution.

II.—Rods (termed "stock"); Product department primarily.

III.—Castings, bar steel; Machinery department primarily.

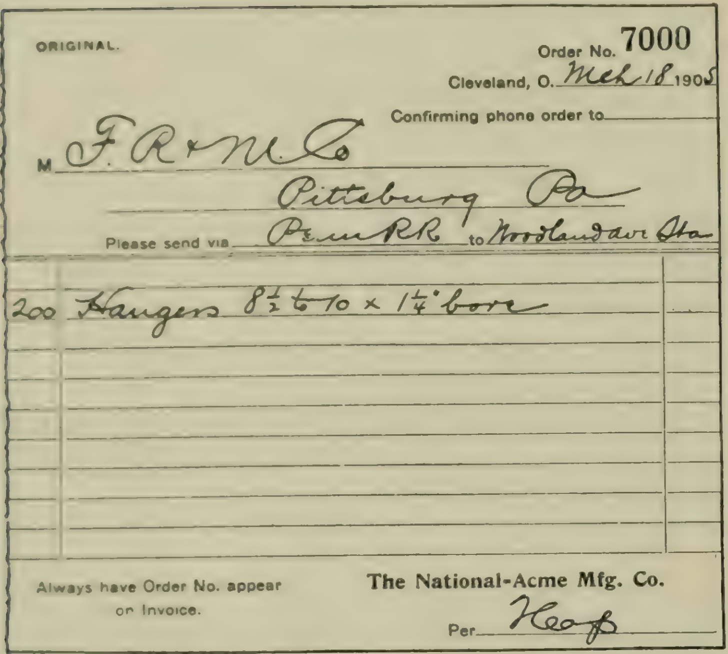
While material on both II and III is carried for direct account of the respective department, occasional deliveries are made from either to the other, the items being invoiced at cost plus carrying charges, with adjustments effected monthly. Such transactions are treated as of the nature of transfers and have no bearing whatever upon sales proper.

1. Small stores.—The main details of purchase, receipt, and distribution are centered in this division. A purchasing agent with a retentive memory is possessed of a valuable asset, and by virtue of it is relieved of much drudgery; but it must be used as an aid only and not trusted implicitly. To fortify it he is supplied with a card file of quotations kept within convenient reach of his desk. This quotation card is headed with the article quoted on and alphabetically filed; it shows:—date of quotation; by whom quoted; prices; terms; remarks.

The factory source from which any order not out of the ordinary may have its inception is not restricted. A want memorandum—ordinary blank form—stating plainly what is required, reaches the purchasing agent after having been O. K.'d by foreman, superintendent or officer of the company, depending on convenience or circumstances. The privilege of exercising reasonable discretion is delegated to the purchasing agent, so that unless manifestly wrong the order is promptly placed by him according to memorandum.

The order blanks (Form 1) which are made in triplicate with carbons, are bound in books, 100 sets of orders to each. There are numerous concerns from which material is ordered with more or less regularity, and to each of these an entire book is allotted. The name is typewritten, pasted on the back, and the book filed in a drawer with the labeled end up. By having an assistant fill all blanks in advance as far as possible, the work of ultimately completing the order is reduced to a minimum. Miscellaneous purchases are made through a current order book labeled "sundries."

When an order is made out the duplicate remains in the book; the original and triplicate are detached. Before removing the tripli-



ORIGINAL.

Order No. 7000

Cleveland, O. Mch 18 1905

Confirming phone order to

M F R & M Co

Pittsburg Pa

Please send via Penn RR to Woodlandave Sta

200 Hangers 8½ to 10 × 1¼" bore

Always have Order No. appear on Invoice.

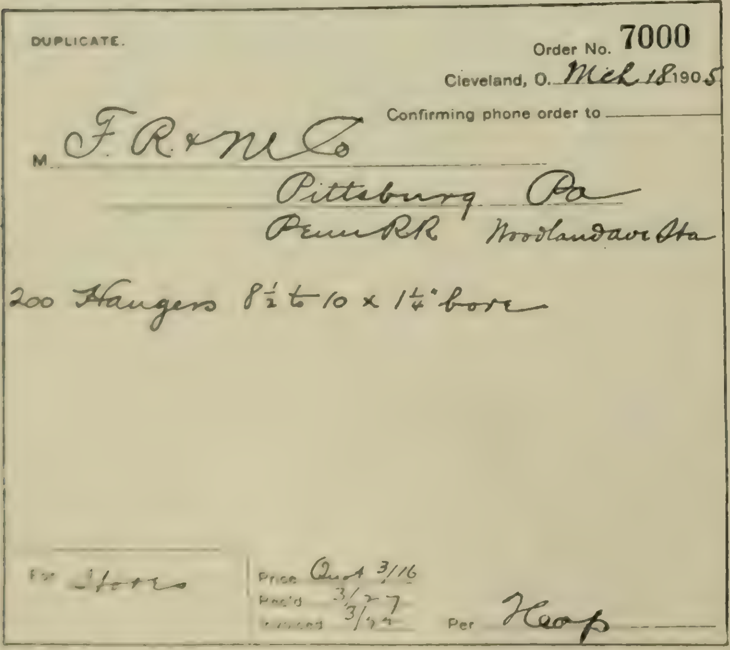
The National-Acme Mfg. Co.

Per Heap

FORM I A. ORDER BLANK.

Original is 6 by 5½ in., thin white paper. Detached by tearing off at the left-hand margin.

cate, a brief notation—initials, department or purpose—is made in the lower left-hand corner. Any reference to price is usually noted on the duplicate only. The original is now sent to the party that is to supply the goods; the triplicate, which is perforated for Shannon file, goes to the store keeper who files it alphabetically. His written standing instructions are to report promptly if goods ordered are not received within a "reasonable time." That may be merely the fraction of a day or several weeks when no specific time is given. The storekeeper, if competent, will not unnecessarily trouble the office nor neglect to keep the purchasing agent duly informed if the goods are not delivered on time. Until direct orders are given him to desist he is required to report daily in writing—name, date and order number only—the non-receipt of all material overdue.



DUPLICATE.

Order No. 7000

Cleveland, O. Mch 18 1905

Confirming phone order to

M F R & M Co

Pittsburg Pa

Penn RR Woodlandave Sta

200 Hangers 8½ to 10 × 1¼" bore

For Store

Price Quot 3/16

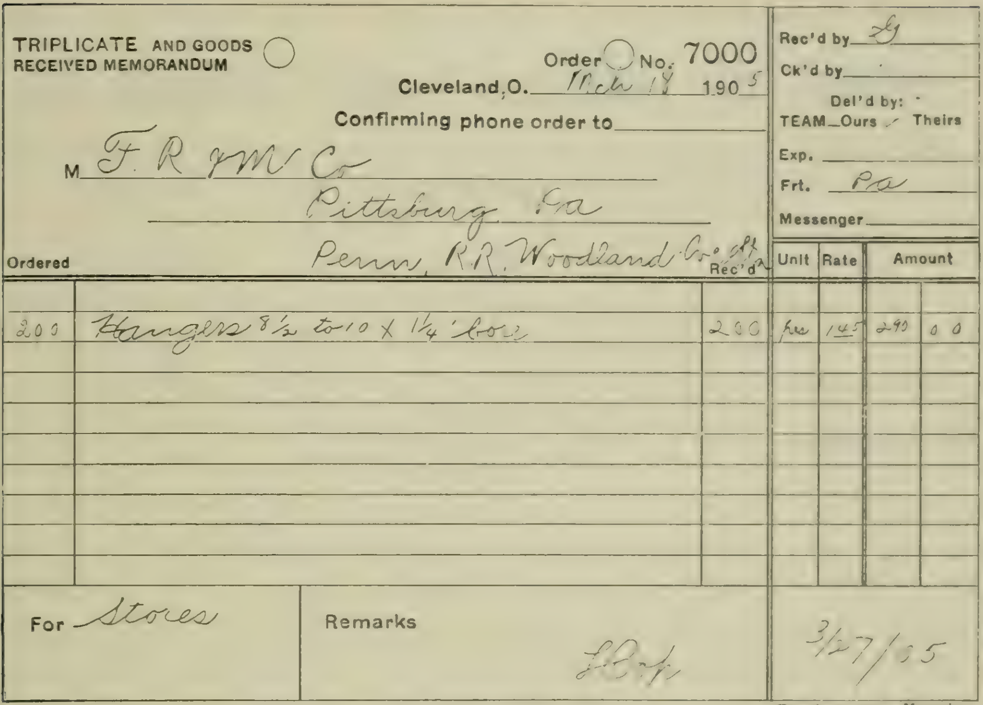
Rec'd 3/27

[illegible] 3/27

Per Heap

FORM I B. CARBON DUPLICATE OF FORM I A.

Following the receipt of the goods, the store keeper sends the triplicate to the office, after having endorsed thereon the date



TRIPLICATE AND GOODS ○
RECEIVED MEMORANDUM

Order ○ No. 7000
Cleveland, O. Mch 18 1905
Confirming phone order to

M F. R & M Co
Pittsburg Pa
Penn. R.R. Woodland Co. [illegible]

Rec'd by G
Ck'd by
Del'd by:
TEAM Ours ✓ Theirs
Exp.
Frt. Pa
Messenger

Ordered		Rec'd	Unit	Rate	Amount	
200	Hangers 8½ to 10 × 1¼ 'box	200	pcs	145	290	00

For Stores

Remarks

3/27/05

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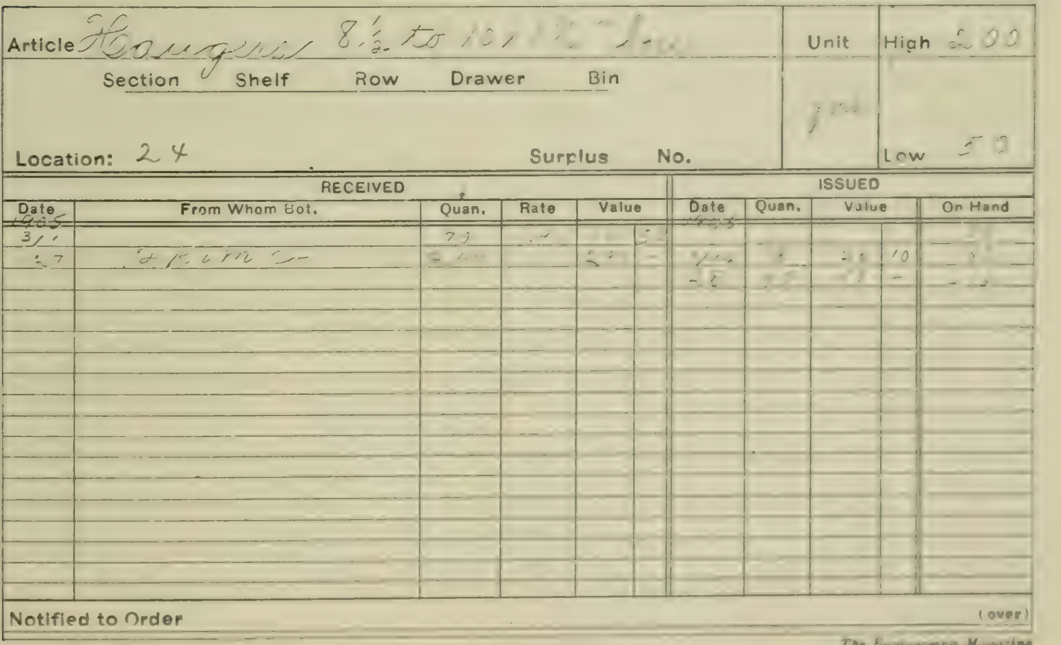
FORM I C. TRIPLICATE, WITH STUB.

and quantity received, by which freight line or express company, etc. To guard against possible loss of any triplicate while in transit, or against neglect to return it promptly to stores room. the store keeper makes a daily slip with carbon copy for the purchasing agent, on



Article Hangers 8½ to 10 [illegible]
Section Shelf Row Drawer Bin
Location: 24 Surplus No.
Unit pcs
High 200
Low 50

RECEIVED					ISSUED			
Date	From Whom Bot.	Quan.	Rate	Value	Date	Quan.	Value	On Hand
~~1905~~					[illegible]			
3/[illegible]		[illegible]	[illegible]	[illegible]				
[illegible] 27	F R & M Co	[illegible]		[illegible]	[illegible]	[illegible]	[illegible] 10	[illegible]
					[illegible]	[illegible]	[illegible]	[illegible]

Notified to Order (over)

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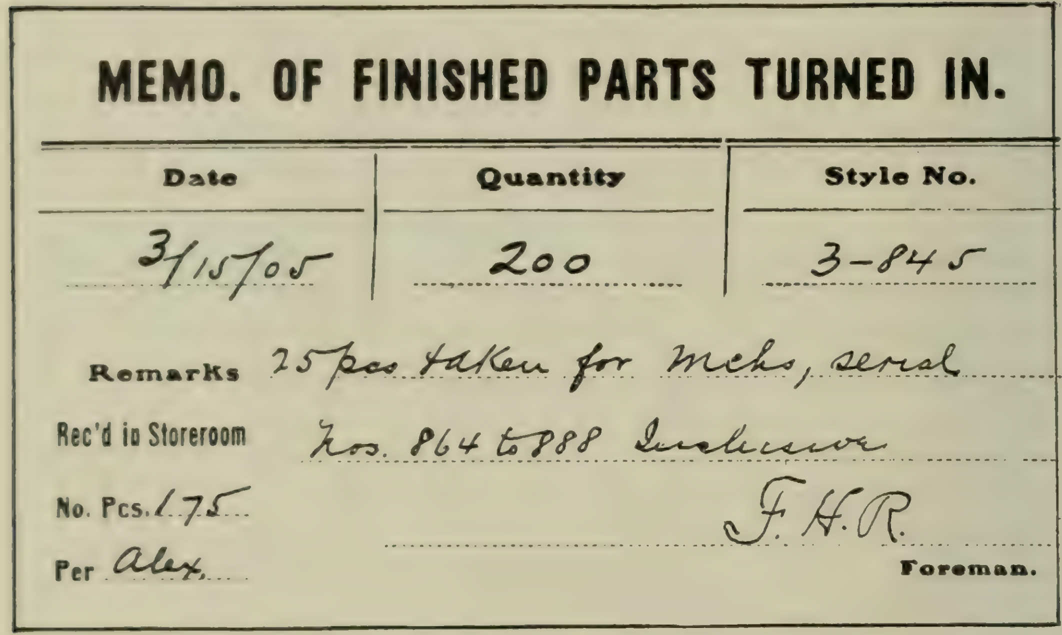
FORM 2. RECORD OF STORES BOUGHT.

Salmon card, 8 by 5 in. The column ruling is carried on the back, also. Form 3, Record of Stores Manufactured, is similar, but on a buff card.



MEMO. OF FINISHED PARTS TURNED IN.

Date	Quantity	Style No.
3/15/05	200	3-845

Remarks 25 pcs taken for mchs, serial

Rec'd in Storeroom Nos. 864 to 888 Inclusive

No. Pcs. 175

Per Alex

F.H.R.

Foreman.

FORM 4. MEMORANDUM OF FINISHED PARTS TURNED IN.

Original is 5 by 3 in., thin white paper, blocked in pads.

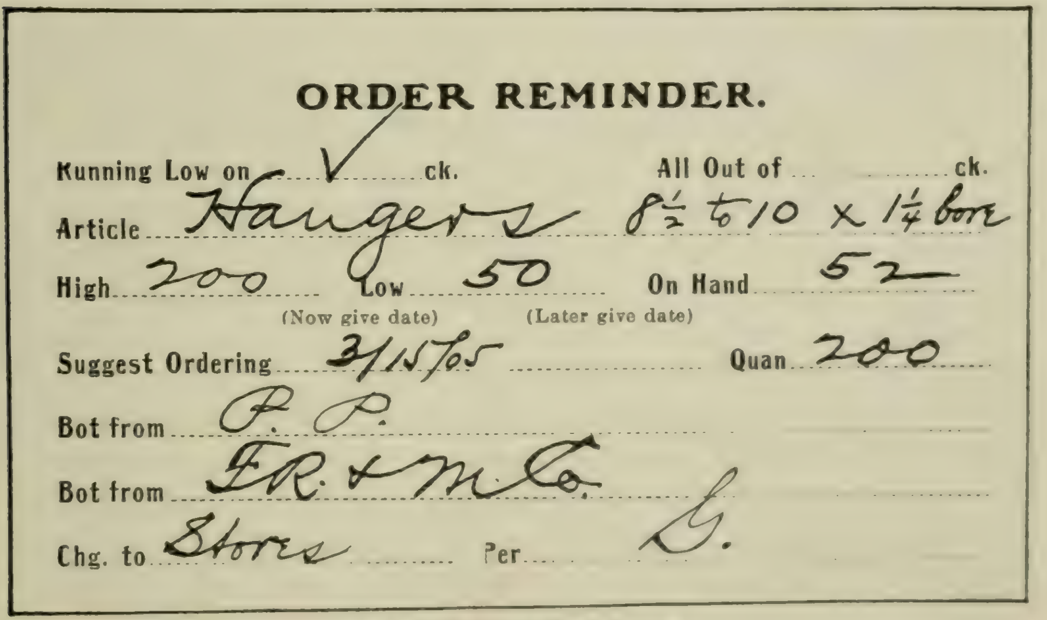
which he records simply the order numbers of those sent to the office, checking them off when returned and making demand for any not promptly sent back. At the office, through the purchasing agent, the values at the right are filled in, when this form again goes to the store keeper, now furnishing him the necessary data for the stores-bought card. (Form 2.)

Form 3 (buff), essentially the same as Form 2, provides for a record of material manufactured as distinguished from goods bought. For the former, invoices give the value, while prime costs on the latter are obtained from the cost records. Both provide for a running or perpetual inventory.

A "Memorandum of Finished Parts Turned In" (Form 4) accompanies each contingent from the factory which goes into the stores room. It sometimes occurs that the lot as put through according to the records does not correspond in count with the quantity turned over to the store keeper. The difference, accounted for and attested to by initials of the foreman, is generally represented by parts used for current construction work taken in advance of their having gone through the stores room, but only by consent or knowledge of the foreman. The record will show the lot turned in complete—the difference, as having been issued.

For calling attention to items running low or out, an "Order Reminder" (Form 5) is provided. This is on onion-skin paper and is made in carbon duplicate by the store keeper, the original going to the party interested, the duplicate being retained. Unless an order is placed within a "reasonable time," evidence of which and his only notification being an order triplicate, second or more notices are given until an order is placed or instructions have been received to desist. A busy foreman may be excused for neglecting or forgetting to start the order promptly, or for misplacing the memorandum on receipt of first notice, but not after a second or third. The store keeper must not forget, nor long permit the foreman to do so.

A requisition-for-stock blank is shown in Form 6. Anyone around the factory in want of material can fill out one of these; it requires a foreman's approval, initials only, to make it pass current. A requisition for material other than that in the stores room results occasionally in a cross departmental charge. An order of this nature must further be approved by the regular head of the opposing department, which serves to guard against inadvertently appropriating material in sight that may have been intended and more urgently needed for the regular requirements of the contributing department. The liberal spacing between lines on this form is for the convenience of the factory employee, who as a rule dislikes being restricted for room when it is necessary to use a pencil. This is not to be considered as any reflection on the mechanic—far from it, for he is usually as well qualified to handle proficiently the tools pertaining to his calling as is the clerk his pen. (It may be of interest to note here that the detailed stores-room inventory taken at the close of the last fiscal year to verify the record cards and compare with the ledger



ORDER REMINDER.

Running Low on ✓ ck. All Out of .... ck.

Article Hangers 8½ to 10 x 1¼ bore

High 200 Low 50 On Hand 52

(Now give date) (Later give date)

Suggest Ordering 3/15/05 Quan 200

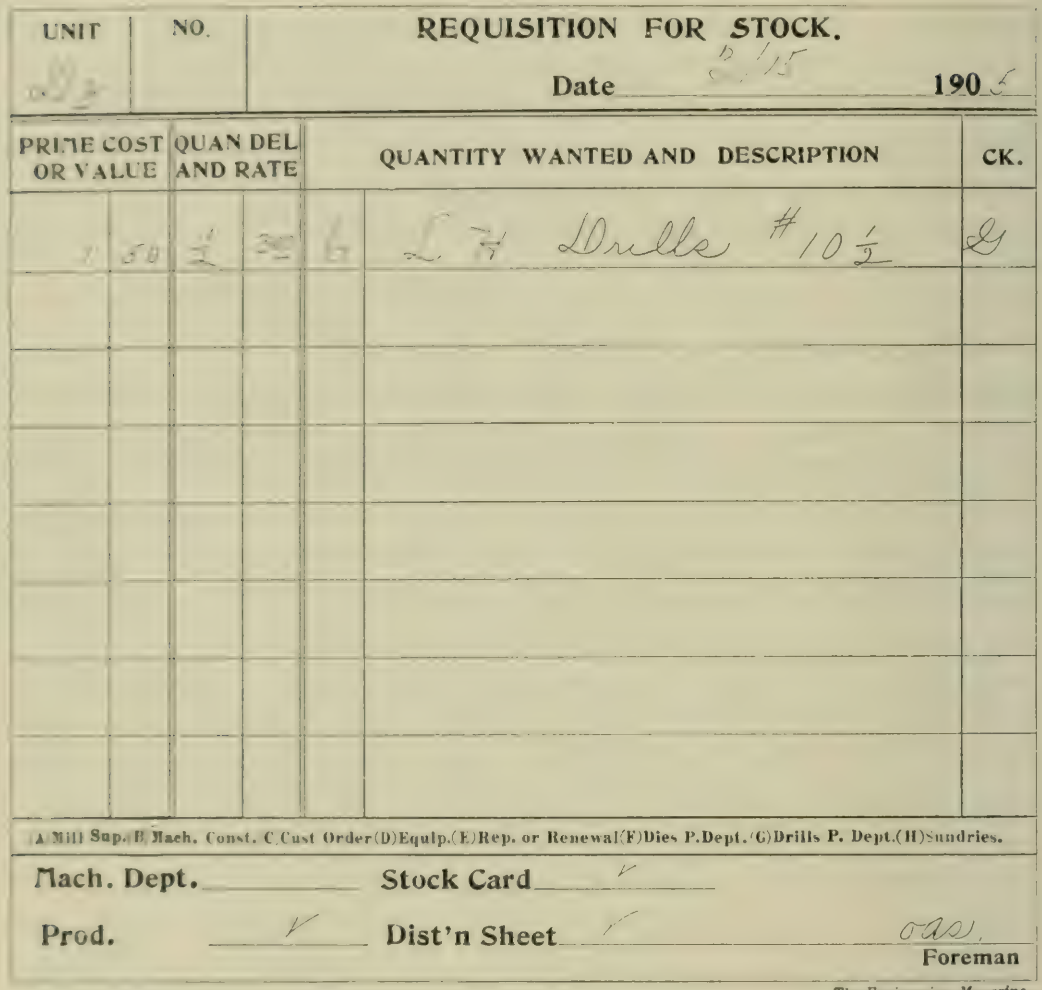
Bot from P. P.

Bot from F. R. & M. Co.

Chg. to Stores Per G.

FORM 5. ORDER REMINDER.

Original is 5 by 3 in., thin white paper, blocked in pads.



UNIT	NO.	REQUISITION FOR STOCK.
G		Date 2/15 1905

PRIME COST OR VALUE		QUAN DEL AND RATE		QUANTITY WANTED AND DESCRIPTION		CK.
1	50	2	30	6	2 ¾ Drills #10½	G

A Mill Sup. B Mach. Const. C Cust Order (D) Equip. (E) Rep. or Renewal (F) Dies P. Dept. (G) Drills P. Dept. (H) Sundries.

Mach. Dept. ____________ Stock Card ✓

Prod. ✓ Dist'n Sheet ✓ OAW.

Foreman

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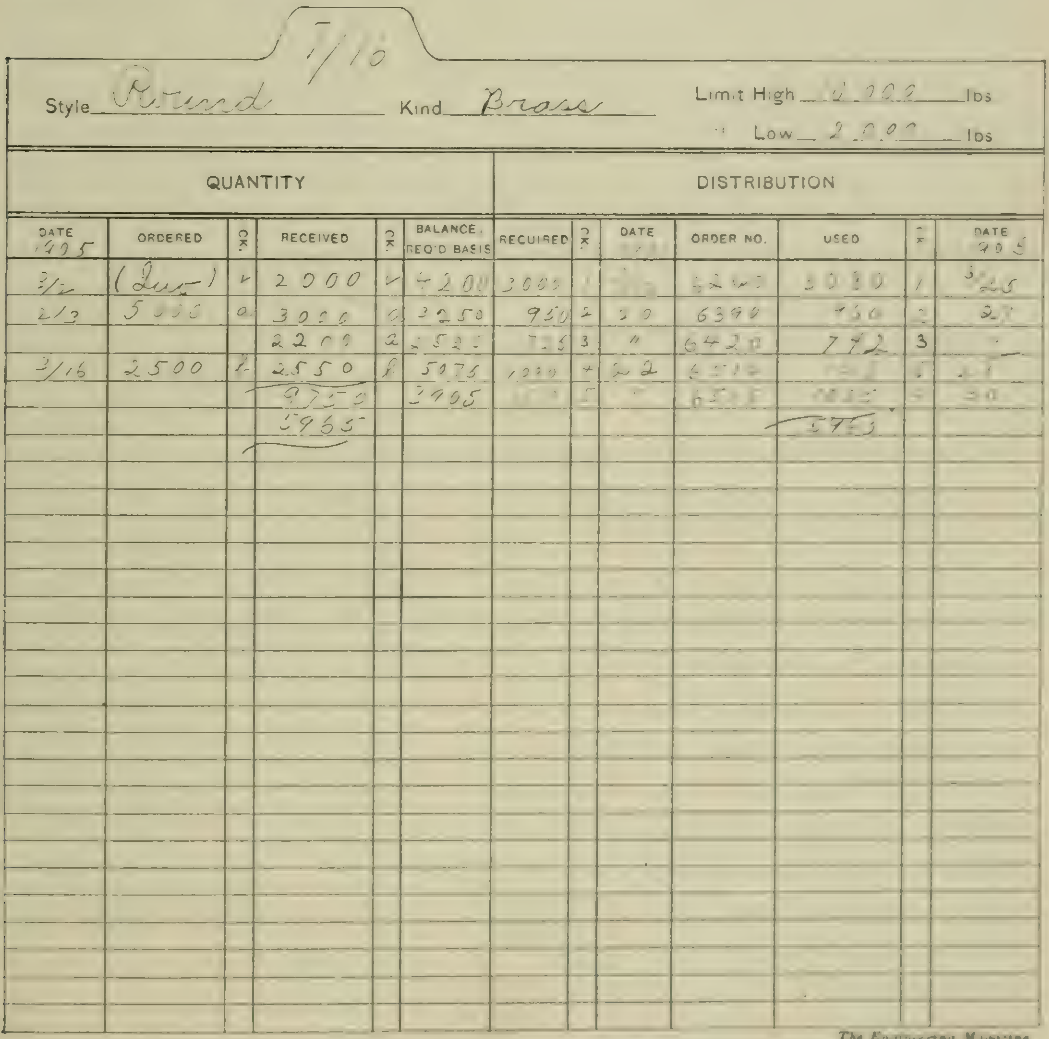
FORM 6. ORIGINAL IS 6¼ IN. WIDE BY 6 IN. HIGH, YELLOW PAPER.

stores account showed a difference in value of less than ten dollars).

II. Rods; Product Department.—The consumption of material under this division approximates upwards of a car load daily—sufficient to keep several men steadily employed receiving and distributing. Several floors of multiple-spindle screw machines demand an incessant supply of rod. The head of this division is held accountable for receipts and disbursements, but he has nothing to do with ordering; that is taken care of through the factory office. To operate with profit a contingent of automatic machines, it is very essential that they be kept steadily running. Power excepted, expenses both direct and overhead continue unabated whether the machinery is turning out product or for any reason stands idle. A careful analysis of the records brings out with emphasis the necessity for exercising much care to guard against the stoppage of machines for want of material. The trouble is augmented rather than otherwise if, when an average order has been run off in part only, it is discovered that a lack of rod prevents completing it. To hold the machine waiting is unprofitable; to "break up" and put it on to other work, necessitating a second "setting up" on the first order, is possibly even less profitable. Manifestly, the factor of supply must have careful consideration.

With the aid of a card, as per Form 7, a satisfactory check can be kept on conditions in the (rod) stock house. A separate one is made for each size rod used, and also each style—round, square, hexagon, etc.—and each kind—brass, iron, steel, etc. The tabs are used for the sizes which are conveniently arranged first by eighths, next by sixteenths, then by thirty-seconds, followed by sixty-fourths, and after these, decimal sizes according to numerical value. It is aimed to keep a stock of all sizes more or less constantly used within established high and low limits. The record as kept under the head-



1/10

Style Round Kind Brass Limit High 4 000 lbs
" Low 2 000 lbs

QUANTITY						DISTRIBUTION						
DATE 1905	ORDERED	O.K.	RECEIVED	O.K.	BALANCE, REQ'D BASIS	REQUIRED	O.K.	DATE	ORDER NO.	USED	O.K.	DATE 1905
3/2	(Due)	✓	2000	✓	4200	3000	1	[illegible]	6200	3030	1	3/25
2/3	5000	0	3000	0	3250	950	2	20	6390	750	2	27
			2200	2	2525	725	3	"	6420	772	3	
3/16	2500	1	2550	1	5075	1000	4	22	6510	[illegible]	4	[illegible]
			9750		3905	[illegible]	5	"	6530	[illegible]	5	30
			5965							5753		

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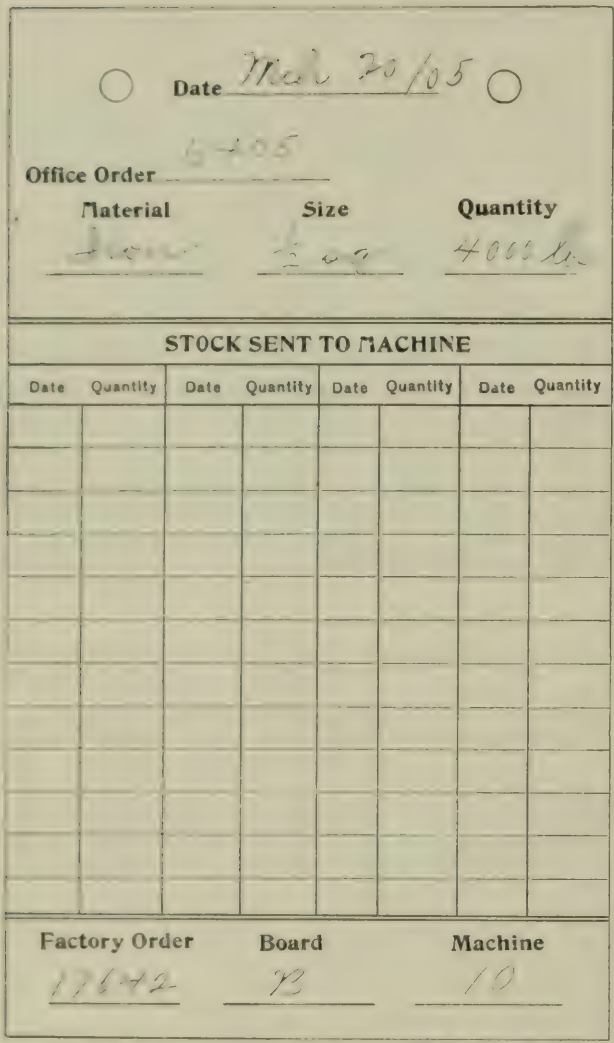
FORM 7. RECORD OF RODS IN THE STOCK HOUSE.

White card, 6 in. wide by 5½ in. high.

ings "Quantity—Distribution" needs perhaps a brief exemplification. Assume that 5,000 pounds of rod have been ordered; that shipments of 3,000 and 2,200 pounds respectively have subsequently been received. The quantity ordered has been slightly over-run; it sometimes falls a trifle short; in either event the mill is apt to treat the order simply as filled. In the two left-hand "ck." columns, check, preferably by using letters, the quantity ordered against the shipments made. Assume next that 3,000 pounds are required for an order. This amount is at once written in the "Required" column (date and order number being filled in) and deduction is made from stock, the remainder being shown under "Balance, Req'd Basis." Note, that the order might have come to hand and likewise have been recorded in advance of the receipt of material. The balance then would presumably have been a negative quantity, in which event red-ink figures are always used. Rod is delivered from stock to the machines in quantities to suit convenience, each lot first having been listed on the requisition slip (the issuing of which will be referred to directly) and when the order is filled, the slip is returned to the factory office where it originated. The date (final one only) and total amount in pounds used are then entered on the card. The probabilities are remote that the pounds required and those used will tally, for the reason that each machine takes 40 feet of rod (four 10-foot bars) to a single load. But care must be exercised, as only a reasonable amount of deviation, say not to exceed 5 per cent., is permissible. Checking now the "Used" against the "Required," (prefer-



○ **Date** Mch 20/05 ○

6-405

Office Order

Material	**Size**	**Quantity**
[illegible]	[illegible]	4000 lb.

STOCK SENT TO MACHINE

Date	Quantity	Date	Quantity	Date	Quantity	Date	Quantity

Factory Order	**Board**	**Machine**
17642	B	10

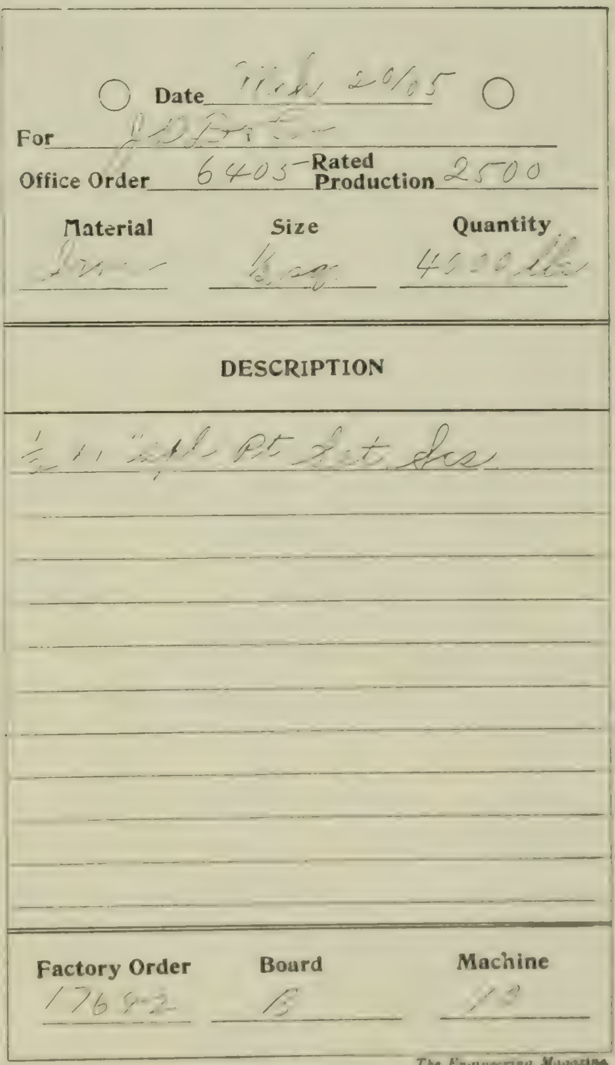
The Engineering Magazine

FORM 8 A. REQUISITION FOR ROD.

Original is 4 by 6½ in., Thin Yellow Paper.

ably by numbers, letters having been used on the "Quantity" side) and the assumed transactions are practically completed. It will be noted that no provision has been made on the card for an actual balance. This is readily arrived at by deducting the "Used" from the "Received" and proved by adding to or deducting from the "Balance, Req'd Basis" amount, the difference between the "Required" and the "Used"; subtract if amount "Used" is greater, add if less. In practice it is found quite satisfactory to run through several orders before making the adjusting notation and bringing down the true balance for a new start. It should be borne in mind that several orders using the same size rod are commonly in incomplete shape at one time. If for any reason it is required at this stage to know the true condition of the stock, it can be ascertained at short notice and with no unnecessary labor.

All requisitions for rod are issued from the factory office. They are made in triplicate with carbons at practically one writing, although no two are just alike. (See Form 8). The blanks are perforated for Shannon file and padded, first yellow, next white, then pink. All orders for special goods take consecutive main-office order numbers in addition to factory order number, while orders for stock goods take the latter only. This enables anyone interested to discern at a glance whether the goods will be for shipment or shelf. The nature of the product would not necessarily tell; stock goods so considered ordinarily are generally treated as though special



○ Date Mch 20/05 ○

For [illegible]

Office Order 6405 Rated Production 2500

Material	Size	Quantity
[illegible]	[illegible]	4000 lbs

DESCRIPTION

[illegible]

Factory Order	Board	Machine
17692	13	[illegible]

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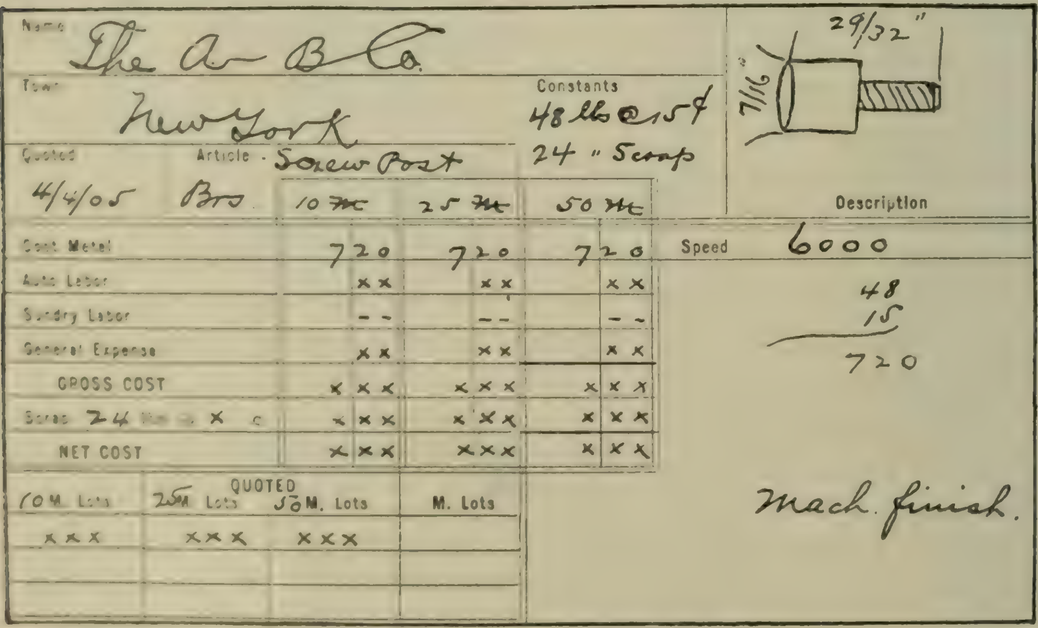
FORM 8 B. PARTIAL DUPLICATE OF 8 A. SAME SIZE WHITE PAPER.

8c ("pink ticket") is identical except that it is initialed by the operator.

when required to fill an order, and strictly special parts are considered as regular when the orders are for deliveries at stated periods covering a considerable length of time. The yellow ticket is sent to the (rod) stock house. It is dated and numbered, and contains information as to kind, size and quantity of material, likewise destination of the rod, row (board), and machine. The boards are designated A.B.C., etc.; the machines number from one up on each board. After removing the yellow slip and one carbon, the white ticket is completed by inserting name, usually initials only, and an amount after "Rated Production." This is not an arbitrary figure, but taken, if the product is a special, from a card giving information in detail relative to the making of the piece, recorded when the quotation was made (Form 9). The rate on standard screws is taken from previously established records. Thus is the element of guess-work so far as the operator is concerned entirely eliminated; if he can improve on the quantity, well and good; but he must consult his foreman if for any reason he fails to reach it.

Under "Description" all necessary working instructions are given; if special, make to sample, specifications or drawing, with or without deviation; if standard, then kind, length, style of point, thread, etc. The white slip remains on file in the office of issue; the pink one goes into the mill. It is important to know what operator was identified with the making of the product; his initials or number must be affixed to the pink slip when the order is started.


Name The A B Co.
Town New York
Constants 48 lbs @ 15¢
24 " Scrap
Quoted 4/4/05 Bro
Article - Screw Post

Description

	10 M	25 M	50 M
Cost Metal	720	720	720
Auto Labor	x x	x x	x x
Sundry Labor	– –	– –	– –
General Expense	x x	x x	x x
GROSS COST	x x x	x x x	x x x
Scrap 24 [illegible] x c	x x x	x x x	x x x
NET COST	x x x	x x x	x x x

Speed 6000

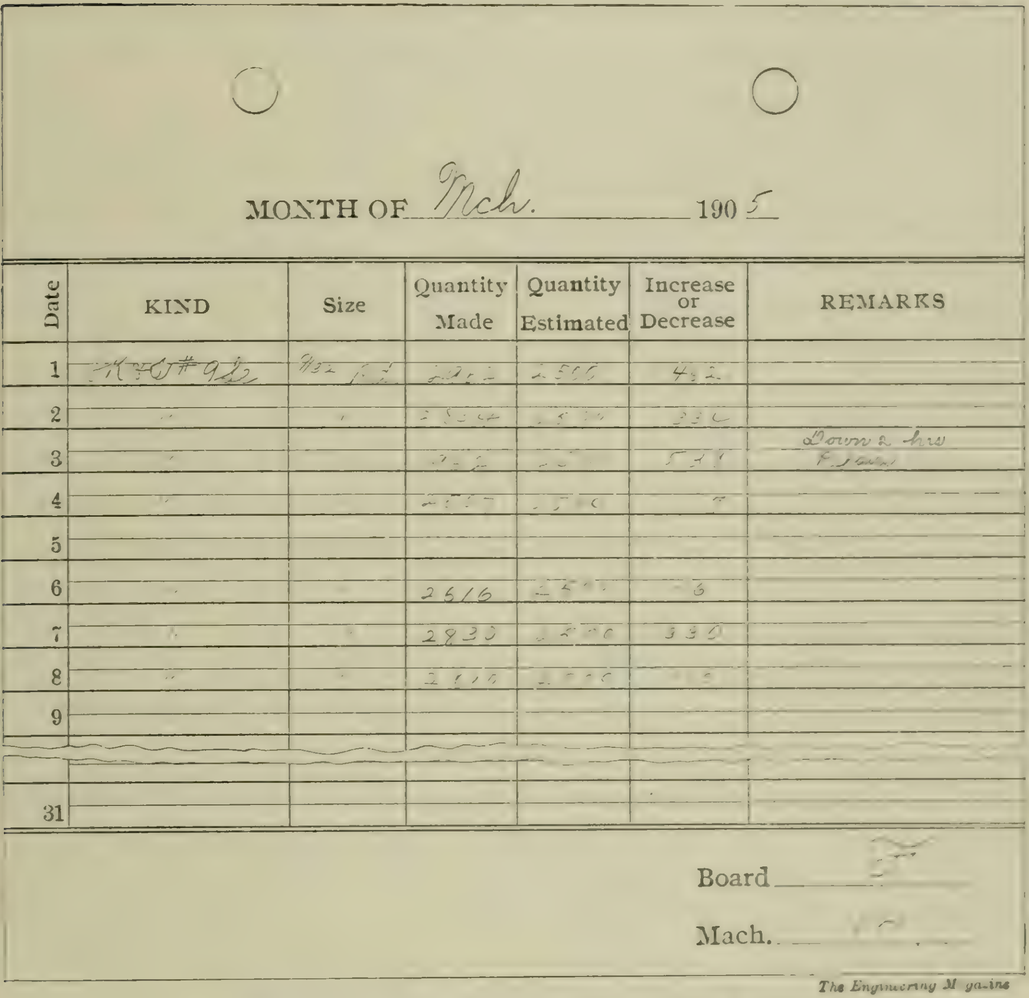
48
15
720

Mach. finish.

QUOTED			
10 M. Lots	25 M. Lots	50 M. Lots	M. Lots
x x x	x x x	x x x	

FORM 9. INFORMATION CARD FOR RECORDING QUOTATIONS.

Original is 5 by 3 in., perforated for card-index rod; white paper. The reverse is ruled for the listing of "sundry labor" on a series of special operations.



MONTH OF Mch. 1905

Date	KIND	Size	Quantity Made	Quantity Estimated	Increase or Decrease	REMARKS
1	[illegible]	[illegible]	[illegible]	2500	[illegible]	
2	"	"	[illegible]	[illegible]	[illegible]	
3	"		[illegible]	[illegible]	[illegible]	Down 2 hrs [illegible]
4	"		[illegible]	[illegible]	[illegible]	
5						
6	"		2616	[illegible]	[illegible]	
7	"	"	2830	[illegible]	330	
8	"	"	[illegible]	[illegible]	[illegible]	
9						
31						

Board

Mach.

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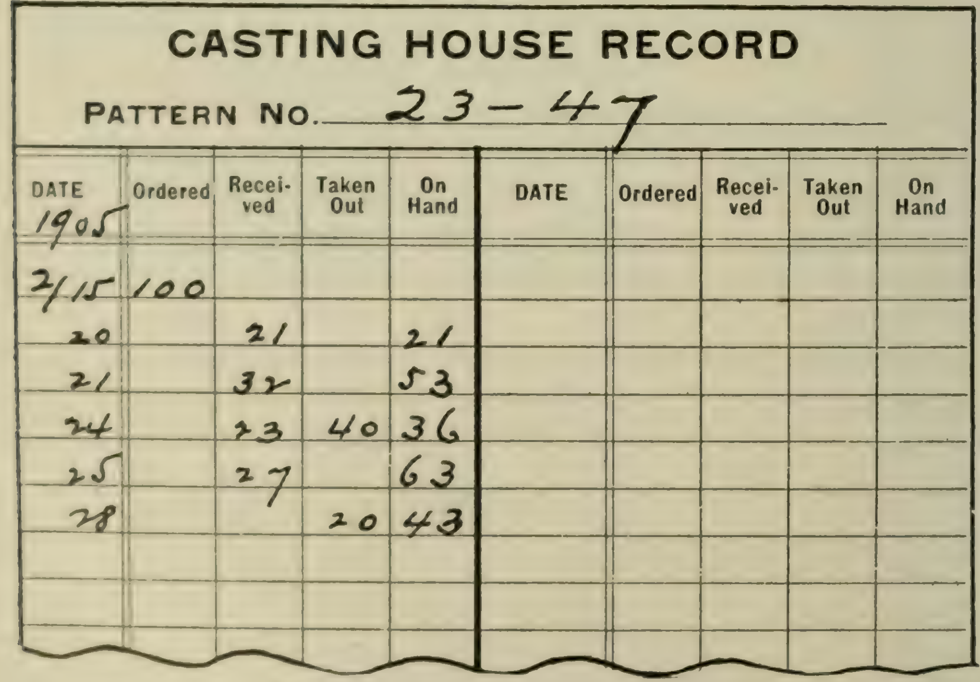
FORM 10. DAILY INDIVIDUAL MACHINE RECORD.

The original is 5½ in. wide by 10½ high, white paper. The figure "538" in the right-hand column should appear in red ink.

The yellow ticket is returned to the office when a proper quantity of rod has been delivered in the mill, and the pink one goes back as soon as the order is off the machine; all three are then systematically filed away.

An operator must keep his machines going if possible. He knows that the daily individual machine record (Form 10) will tell, even if he neglects to, whether or not they have been kept steadily running, and if not the reason why is noted on the sheet; "no rod" will not answer if any was to be had. The stock keeper (rod) delivers material as a rule only on a properly executed order, but this is subject to one exception of limited occurrence. Should an operator for any reason be short of rod he is to use the nearest telephone on his own floor and make direct request for the delivery of one set (four) rods, giving size, kind, and where wanted. This verbal order is, if possible, given immediate attention; at the same time a memorandum of the stock so delivered must go to the factory office where its receipt means an investigation at once. The matter is usually settled then and there and the records corrected if necessary.

III. Castings, Bar Steel; Machinery Department.—A general order to the superintendent for the making of a lot of machines is accompanied or promptly followed by a detailed list of the required castings and bar steel; lists for all other material follow in due course thereafter. A surplus stock of castings is carried at all times; hence the quantities of some to be ordered will vary from the list, the difference, whether more or less, being contingent upon the number on hand. The bin and storage arrangement of the castings house is such that the proper place for any particular casting can be readily located. Attached to each separate division is a card holder which contains a card (Form 11) showing:—pattern number—ordered—received—taken out—on hand—and affording a satisfactorily close running inventory. The party in charge of castings makes daily report of all receipts and deliveries. Receipts must correspond in pounds with foundry advices, and deliveries on orders must not (without written instructions) exceed in count the unfilled balances according to his records. The memorandum of castings-delivered ticket (Form 12) is an informal "foreman's sub-order" which incidentally serves notice that the factory will soon be ready to commence the machining of certain parts and calls for their delivery at a particular place. Car-



CASTING HOUSE RECORD

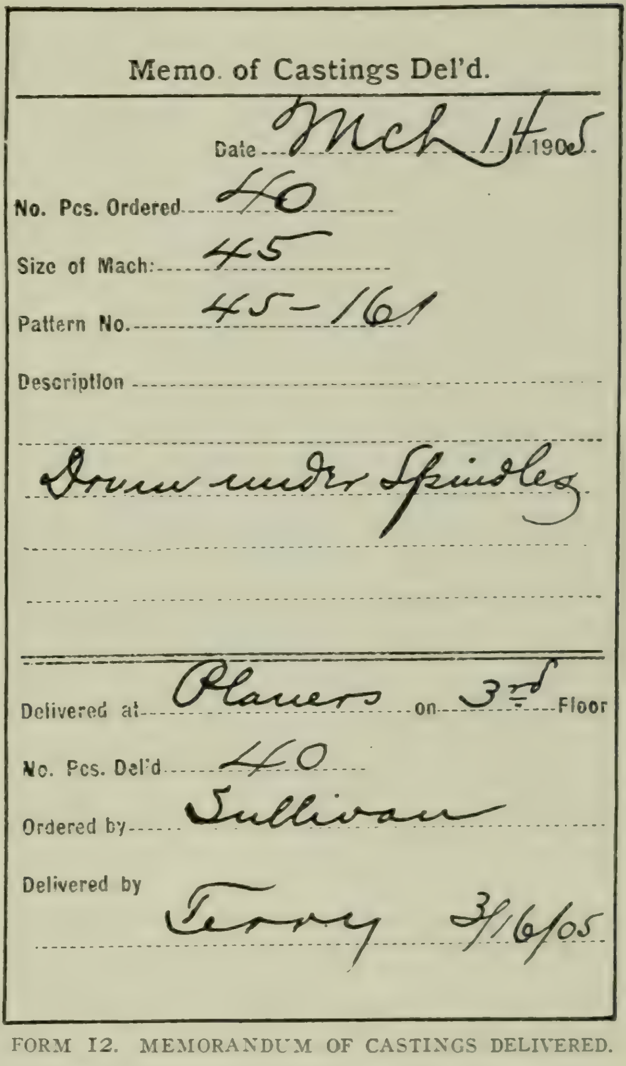
PATTERN NO. 23-47

DATE 1905	Ordered	Received	Taken Out	On Hand	DATE	Ordered	Received	Taken Out	On Hand
2/15	100								
20		21		21					
21		32		53					
24		23	40	36					
25		27		63					
28			20	43					

FORM 11. CASTING HOUSE RECORD.

The original is 4 by 7 inches, buff card, printed alike on both sides.

bon duplicate is made, one slip going with the goods, the other to the office. Unless the full quantity ordered is delivered, inquiry concerning the balance should be made before starting, to guard against holding machines idle or the possible necessity for setting up two or more times.



Memo. of Castings Del'd.

Date Mch 14 1905

No. Pcs. Ordered 40

Size of Mach: 45

Pattern No. 45-161

Description

Drum under Spindles

Delivered at Planers on 3rd Floor

No. Pcs. Del'd 40

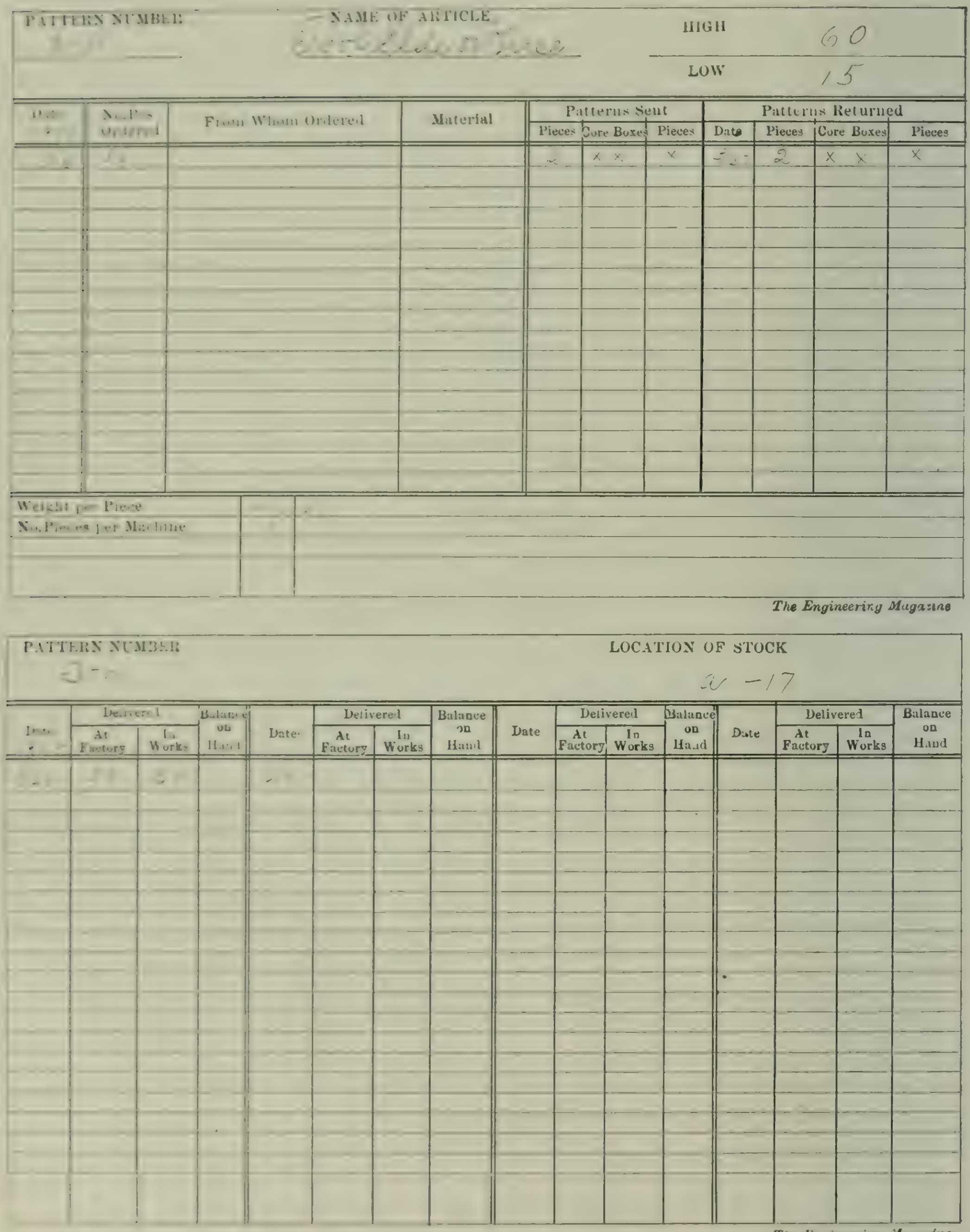
Ordered by Sullivan

Delivered by Terry 3/16/05

FORM 12. MEMORANDUM OF CASTINGS DELIVERED.

Original is 3 by 5 inches, thin white paper, blocked in pads.

The office record of castings is independently kept and in more detail (see Form 13). Only when the metal is other than grey iron are the spaces under "From Whom Ordered" and "Material" filled out. The sending of patterns to and their return from the foundry must be recorded on this form. The "weight per piece" memorandum in lower left-hand corner affords a ready means for converting pieces into pounds when so required. On small parts, where the variation in weight is slight, one amount only is noted; on heavier castings the greatest and least ascertained weights are recorded, and an average used for inventory or other purposes. Article and pattern numbers are always identical. Like parts on all sizes of machines built have the same descriptive or base number, the prefix indicating the size or sizes on which the piece is used. Thus 1-9 and 6-9 both stand for a cylinder, but of radically different dimensions. When, as is frequently the case, the same part serves for use on two or more sizes of machines, the piece number clearly indicates it. 23-18 is a sector gear found on machines Nos. 2 and 3, while 25-364 is a lock bolt of the same dimensions whether for Nos. 2, 3, 4 or 5 machines. When the first two numbers are not consecutive, the miss-



PATTERN NUMBER [illegible]
NAME OF ARTICLE [illegible]
HIGH 60
LOW 15

Date	No. Pcs. Ordered	From Whom Ordered	Material	Patterns Sent			Patterns Returned			
				Pieces	Core Boxes	Pieces	Date	Pieces	Core Boxes	Pieces
[illegible]	[illegible]			[illegible]	x x	x	[illegible]	2	x x	x

Weight per Piece
No. Pieces per Machine

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PATTERN NUMBER [illegible]
LOCATION OF STOCK a -17

Date	Delivered		Balance on Hand	Date	Delivered		Balance on Hand	Date	Delivered		Balance on Hand	Date	Delivered		Balance on Hand
	At Factory	In Works			At Factory	In Works			At Factory	In Works			At Factory	In Works	
[illegible]	[illegible]	[illegible]		[illegible]											

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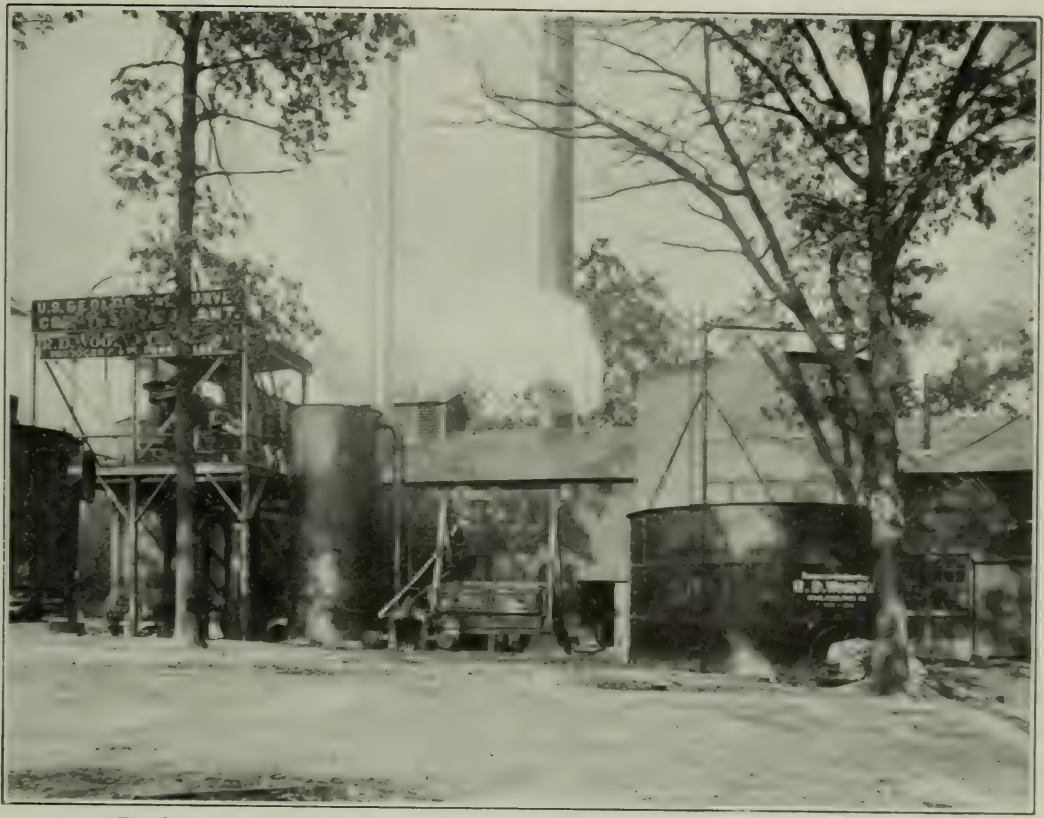
FORM 13. OFFICE RECORD OF CASTINGS.

Stiff card, 8 by 5 in.; the upper figure shows the face, the lower the back of the card.

ing ones are always understood as representing intervening sizes of machines.

Simplicity and practicability have been aimed at in the forms adopted and their application to the receipt and distribution of material. Simple enough to be readily understood and followed, at the same time yielding results sufficiently accurate to be practically correct, and near enough to the automatic in operation to afford little excuse and less reason for unsatisfactory records.



Producer Scrubber Purifier Holder
Economizer Tar Extractor

THE GAS-PRODUCER PLANT.

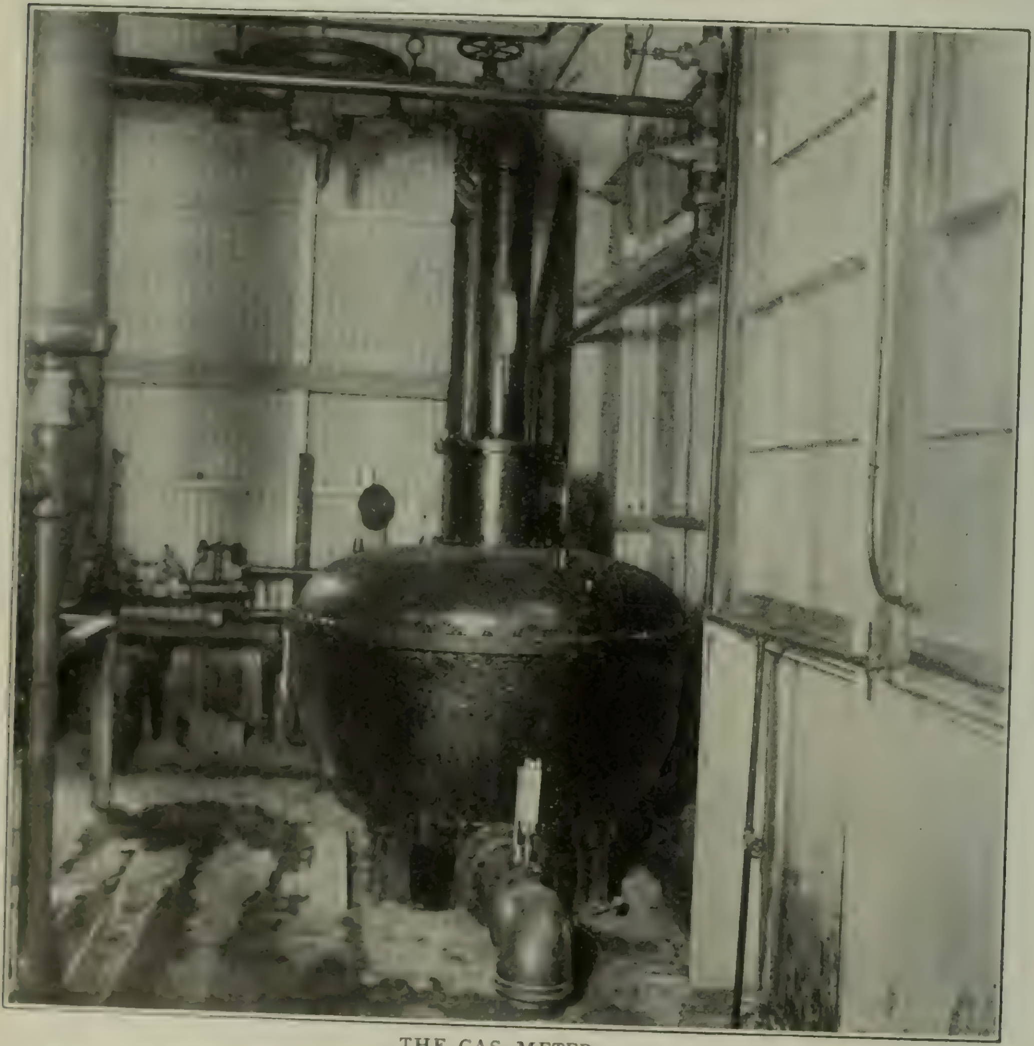
TESTING COALS AND LIGNITES AT THE ST. LOUIS WORLD'S FAIR.

By E. W. Parker.

IN the preceding number of THE ENGINEERING MAGAZINE, the genesis of the coal-testing plant at the St. Louis Exposition was described, the general scope and organization explained, and an outline of the equipment given. The work accomplished and the results obtained were summarized, so far as concerns the chemical analyses and the steam-raising tests, leaving for this issue the synopsis of the gas-producer, briquetting, and coking trials, and the experiments made with various binders for briquetted fuel. These data are concisely presented in the following pages, many of them being arranged in tabular form that they may be more easily interpreted and compared.

Gas-Producing Tests.—The investigations into the gas-producing qualities of the different coals tested were limited to the operation of a producer-gas plant, and using the gas in an explosive gas engine.

The gas, which was made in a Number 7 Taylor gas producer, passed first through an economizer, and then through a scrubber, a tar extractor, and a purifier, into the holder, from which it was drawn into and consumed by a Westinghouse three-cylinder, vertical gas engine, rated at 235 brake horse power.



THE GAS METER.

Under the plan adopted for the tests the quantity of gas produced from each coal was carefully determined, and complete records have been obtained regarding the quality of the gas produced, its value in British thermal units, etc. For this purpose a separate laboratory was maintained and two special chemists were employed to make calorimetric determinations and analyses of the gases.

Complete records were kept of all coal charged to the producer, the steam and water used, the power required to drive the appliances connected with the operation of the producer, the gas generated, and the power developed. Besides these records, readings of thermometers, pressure gauges, calorimeters, etc., were made every twenty minutes during the running time. From these readings complete deductions of the tests have been made.

As was to be expected in such pioneer work as these tests entailed, a number of difficulties developed. Principal among these were the adjusting of the producer operations to the different coals, and of the engine to the greatly varying qualities of the gases. It must be remembered that the maximum time allowed for the gas-producer tests was three days, which included the time necessary to consume all unexpended fuel of a preceding test, and to prepare the bed from the coal next to be tested. Out of the three days only thirty hours were available for actual tests, and these could be secured only by making the test of thirty consecutive hours, requiring the men engaged to be on duty constantly that length of time twice each week.

The difficulties of adjusting the engine to the different qualities of gas were even more disturbing than those which attended the operation of the producer. The main trouble here was in setting the igniters at the proper time relative to the compression of the gas in the cylinder, and any change in the sparking apparatus necessitated the stoppage of the engine. Notwithstanding these and other minor troubles, some valuable results have been obtained, as well as much useful experience which will be available for future work. Mr. Culbertson, the Westinghouse engineer in charge of the gas engine, has had made an adjustable sparking device which it is believed will obviate the difficulties experienced from this cause during the tests. Should Congress appropriate the funds for continuing the operations of the testing plant during the current year, a great many of the mechanical troubles experienced in the past will be avoided.

In the table on pages 214 and 215 is a summary of eighteen gas-producer tests made during the period from October 3 to December 22, inclusive. Probably the most interesting feature of this table is in the results obtained from the poorer grades of coal, and particularly from lignite. Special attention is called to the comparatively high calorific value of the gas obtained from "Texas No. 1" and "North Dakota No. 2," both of which are brown lignites. The average heating value of the former, as expressed in British thermal units, was 160.7 per cubic foot, and that of the latter was 188.5. The best gas obtained from bituminous coals was made from Indiana No. 2, which averaged 159.3 British thermal units per cubic foot, and Indian Territory No. 1, 159.2 British thermal units. On account of the large percentage of water and of ash in the lignites, the amount as mined

BRIEF SUMMARY OF GAS PRODUCER TESTS OF EIGHTEEN BITUMINOUS COALS AND LIGNITES.

Tests		Samples		Coal per hour, lbs.						British Thermal Units.							Cu. ft. standard gas produced. (62° F. 14.7 lbs. pressure.)					
				Consumed in producer.			Equivalent used by producer plant.			Per lb.							Per lb. consumed in producer.			Per lb. equivalent used by producer plant		
Number of test.	Date of test.	Duration in hours.	Name of sample.	Coal as fired.	Dry Coal.	Combustible.	Coal as fired.	Dry Coal.	Combustible.	Coal as fired.	Dry Coal.	Combustible.	Per cu. ft. of standard gas.	From standard gas per lb. of dry coal consumed in producer.	From standard gas per hour per brake horse power.	Per hour.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2	Oct. 10-14	43.00	Alabama No. 2	310.5	299.0	280.0	341.4	328.7	306.8	12865	13365	14820	149.2	9000	11420	18050	58.1	60.4	64.5	52.9	55.0	58.9
15	Dec. 13-14	30.00	Colorado No. 1	364.4	290.7	269.3	428.4	341.7	316.6	9767	12245	13210	149.0	7860	9700	15343	42.1	52.8	57.0	35.8	44.9	48.5
*6	Oct. 31-Nov. 1	30.00	Illinois No. 3	350.0	323.5	289.3	386.0	356.7	319.2	12046	13041	14560	154.8	8330	11460	17412	49.8	53.9	60.2	45.1	48.8	54.5
*9	Nov. 10-11	30.00	Illinois No. 4	350.0	306.3	274.1	398.2	348.5	311.9	11237	12834	14344	151.5	8840	11620	17881	51.1	58.4	65.3	44.8	51.4	57.4
*14	Dec. 2-3	29.67	Indiana No. 1	394.5	349.3	309.5	434.6	384.8	341.0	11534	13037	14720	153.7	7730	11480	17560	44.5	50.3	56.7	40.4	45.6	51.5
*13	Nov. 28-29	7.00	Indiana No. 2	300.0	274.0	244.8	338.0	312.0	278.8	11822	12953	14500	159.3	10140	11750	17450	58.2	63.6	71.3	51.6	55.9	62.6
1	Oct. 3-6	31.00	Ind. Ter. No. 1	361.0	344.0	312.0	392.7	374.0	339.3	12787	13455	14800	159.2	8620	12350	18613	51.6	54.1	59.4	47.4	49.9	54.6
*12	Nov. 25-26	30.00	Kentucky No. 3	370.0	345.3	310.0	410.8	381.2	344.2	12283	13226	14650	155.9	8610	12540	18943	51.2	55.1	61.1	46.2	49.7	55.0
*7	Nov. 3	4.33	Missouri No. 2	346.5	306.0	255.0	384.5	339.6	283.0	10505	11882	14280	140.0	8820	11560	19300	55.7	63.0	75.7	50.2	56.8	68.2
*5	Oct. 24-25	22.33	Montana No. 1	456.5	404.5	355.8	506.8	449.1	395.0	10575	11934	13580	160.8	6580	11340	16540	36.2	40.9	46.5	32.6	36.8	41.9
*10	Nov. 14-15	30.00	N. Dakota No. 2	460.0	278.0	249.0	510.0	308.0	275.8	6802	11255	12600	188.5	7830	13770	11550	25.2	41.5	46.4	22.7	37.5	41.9
*11	Nov. 21-22	21.67	Texas No. 1	590.0	393.0	332.0	660.0	439.5	371.3	7267	10928	12945	169.7	7260	12230	16800	28.4	42.7	50.6	25.5	38.2	45.3
18	Dec. 21-22	19.33	Texas No. 2	468.0	310.3	276.2	519.5	344.4	306.6	7348	11086	12450	156.2	8060	10570	16009	34.2	51.6	57.9	30.8	46.4	52.2
3	Oct. 17-18	24.00	W. Va. No. 1	287.5	283.0	265.5	320.6	315.6	296.1	14166	14396	15350	144.4	9260	11130	18150	63.2	64.1	68.4	56.6	57.5	61.3
4	Oct. 20	9.00	W. Va. No. 4	233.0	229.0	208.0	262.8	258.2	234.5	13918	14202	15600	143.2	11610	11320	18560	79.6	81.2	89.2	70.6	71.9	79.2
17	Dec. 19	6.33	W. Va. No. 9	300.0	292.0	274.9	328.9	320.1	301.4	14195	14580	15500	151.0	8150	10060	15770	52.6	54.0	57.4	48.0	49.3	52.3
*8	Nov. 7-8	30.00	W. Va. No. 12	270.0	266.1	248.7	304.9	300.5	280.9	14614	14825	15860	142.5	10150	11500	18957	70.1	71.2	76.2	62.1	63.2	67.5
16	Dec. 16-17	30.00	Wyoming No. 2	403.3	365.3	281.6	459.8	416.5	321.1	9650	10656	13820	151.0	6168	9516	14923	37.0	40.9	53.0	32.5	35.8	46.5

	Economic results. Lbs. of coal consumed in producer per horse power per hour.												Economic results. Equivalent lbs. of coal used by producer plant per horse power per hour.												Average composition of gas by volume, per cent.					
	Per electrical h.-p. available for outside purposes.			Per electrical h.-p. developed at switchboard.			Per brake h.-p. available for outside purposes.			Per brake h.-p. developed at engine.			Per electrical h.-p. available for outside purposes.			Per electrical h.-p. developed at switchboard.			Per brake h.-p. available for outside purposes.			Per brake h.-p. developed at engine.								
Number of test.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.	Carbonic acid, CO_2.	Oxygen, O_2.	Carbonic oxide, CO	Hydrogen, H_2.	Marsh gas, CH_4.	Nitrogen, N_2.
1	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
2	1.61	1.55	1.45	1.55	1.49	1.40	1.37	1.32	1.23	1.32	1.27	1.19	1.77	1.71	1.59	1.71	1.64	1.53	1.51	1.45	1.35	1.45	1.40	1.30	8.16	.10	16.65	7.20	5.64	62.24
15	1.95	1.56	1.45	1.82	1.45	1.35	1.66	1.32	1.23	1.55	1.23	1.14	2.30	1.83	1.70	2.14	1.71	1.58	1.95	1.56	1.44	1.82	1.45	1.34	10.11	.55	17.38	11.05	5.00	55.90
6	1.82	1.68	1.50	1.75	1.62	1.45	1.54	1.43	1.28	1.49	1.38	1.23	2.01	1.85	1.66	1.93	1.79	1.60	1.70	1.58	1.41	1.64	1.52	1.36	10.53	.15	15.31	8.35	4.46	61.19
9	1.85	1.62	1.45	1.76	1.55	1.38	1.57	1.37	1.23	1.50	1.31	1.17	2.11	1.84	1.65	2.01	1.76	1.57	1.79	1.56	1.40	1.71	1.50	1.34	9.72	.12	15.12	9.98	6.00	59.06
14	2.10	1.86	1.64	1.97	1.75	1.55	1.78	1.58	1.40	1.68	1.49	1.32	2.31	2.04	1.81	2.17	1.93	1.71	1.96	1.74	1.54	1.85	1.64	1.45	9.89	.25	14.10	9.56	6.08	60.13
13	1.57	1.43	1.28	1.49	1.36	1.22	1.33	1.22	1.09	1.27	1.16	1.03	1.77	1.63	1.46	1.68	1.55	1.39	1.52	1.39	1.24	1.43	1.32	1.18	11.80	.07	11.46	10.60	6.10	59.97
1	1.84	1.76	1.59	1.77	1.69	1.53	1.57	1.50	1.36	1.50	1.43	1.30	2.00	1.91	1.73	1.92	1.83	1.66	1.71	1.62	1.47	1.64	1.56	1.41	8.25	.11	19.39	7.69	4.92	59.65
12	1.95	1.81	1.63	1.85	1.71	1.55	1.66	1.54	1.39	1.57	1.46	1.32	2.16	2.01	1.81	2.05	1.91	1.72	1.84	1.71	1.54	1.75	1.62	1.46	10.87	.29	12.45	10.92	6.52	58.95
7	1.87	1.65	1.37	1.74	1.54	1.28	1.59	1.40	1.17	1.48	1.31	1.09	2.07	1.83	1.52	1.94	1.71	1.43	1.76	1.55	1.30	1.65	1.45	1.21	12.07	.20	10.53	7.63	6.33	63.23
5	2.39	2.12	1.86	2.29	2.03	1.78	2.03	1.80	1.58	1.95	1.72	1.52	2.65	2.35	2.07	2.54	2.25	1.98	2.26	2.00	1.76	2.16	1.91	1.68	9.04	.36	18.67	8.00	4.84	59.10
10	3.67	2.22	1.99	3.42	2.07	1.86	3.13	1.89	1.69	2.91	1.76	1.58	4.07	2.46	2.20	3.80	2.29	2.05	3.47	2.09	1.88	3.23	1.95	1.74	8.69	.23	20.90	14.33	4.85	51.02
11	3.16	2.10	1.78	2.98	1.99	1.68	2.68	1.79	1.51	2.54	1.69	1.43	3.53	2.35	1.99	3.34	2.22	1.88	3.00	2.20	1.69	2.83	1.99	1.60	11.10	.22	14.43	10.54	7.48	56.22
18	2.47	1.64	1.46	2.33	1.54	1.37	2.10	1.39	1.24	1.98	1.31	1.17	2.74	1.82	1.62	2.58	1.71	1.52	2.33	1.55	1.38	2.20	1.46	1.30	9.60	.20	18.22	9.63	4.81	57.53
3	1.51	1.49	1.40	1.43	1.41	1.33	1.29	1.27	1.19	1.22	1.20	1.13	1.69	1.66	1.56	1.60	1.57	1.48	1.43	1.41	1.33	1.36	1.34	1.26	10.50	.10	14.34	2.81	5.56	66.69
4	1.23	1.21	1.10	1.17	1.15	1.04	1.05	1.03	.94	.99	.98	.89	1.39	1.36	1.24	1.32	1.29	1.17	1.18	1.16	1.05	1.12	1.10	1.00	10.16	.24	15.82	11.16	3.74	58.88
17	1.60	1.56	1.47	1.49	1.46	1.37	1.36	1.33	1.25	1.27	1.24	1.16	1.76	1.71	1.61	1.64	1.59	1.50	1.49	1.46	1.37	1.39	1.35	1.27	10.40	.20	13.70	9.55	6.60	59.55
8	1.41	1.39	1.30	1.35	1.33	1.24	1.20	1.18	1.11	1.15	1.13	1.06	1.59	1.57	1.47	1.53	1.50	1.40	1.35	1.34	1.25	1.30	1.28	1.20	10.34	.12	14.21	12.98	4.61	57.75
16	2.18	1.98	1.52	2.00	1.82	1.40	1.86	1.68	1.30	1.70	1.54	1.19	2.49	2.25	1.74	2 .28	2.07	1.60	2.11	1.92	1.48	1.94	1.76	1.36	10.21	.59	15.46	10.79	5.52	57.43

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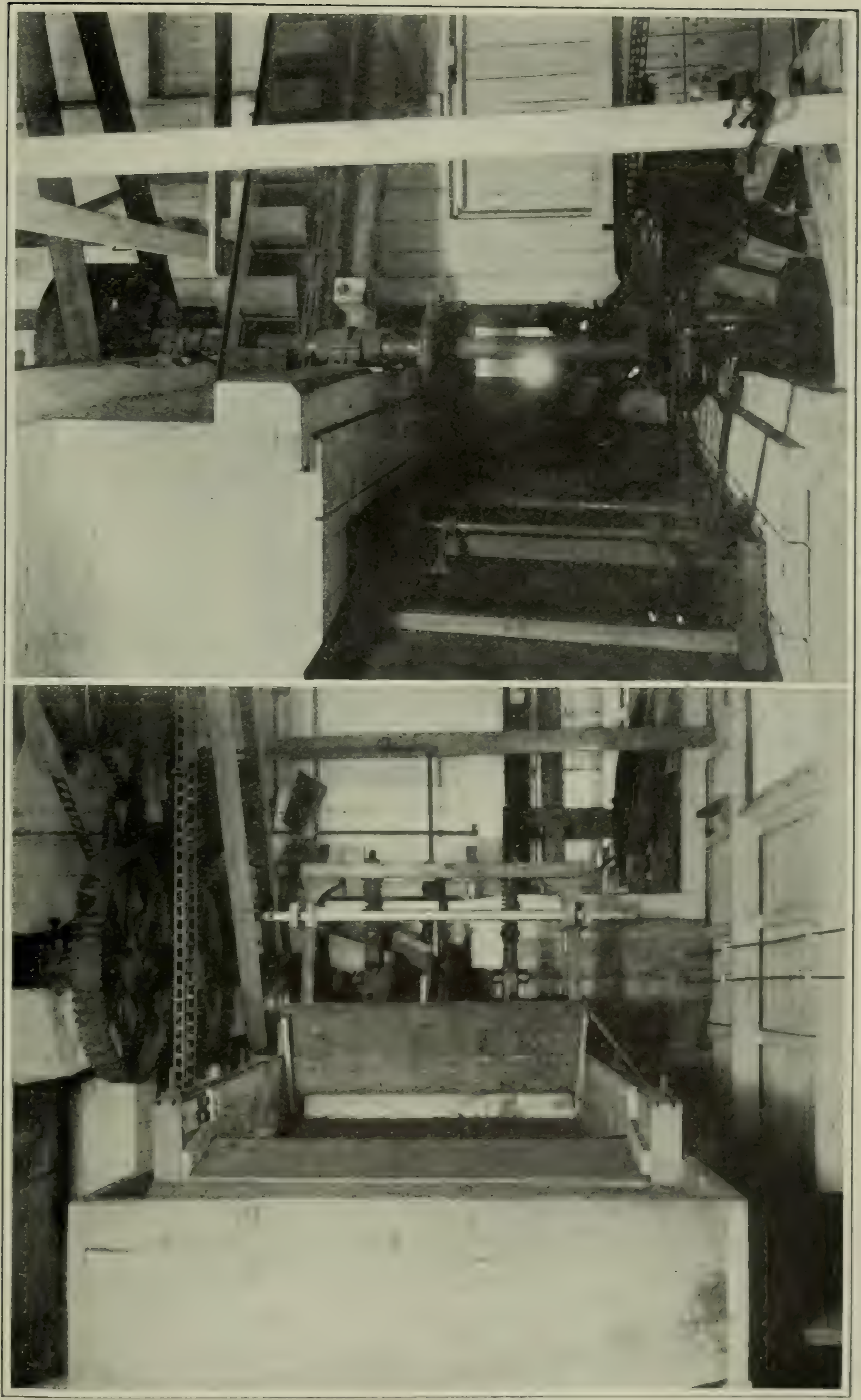
* Gas producer hopper leaked during these tests.

required to produce a certain quantity of gas naturally exceeds the amount of bituminous coal required to produce the same quantity. For instance, one pound of Texas No. 1 yielded only 28.4 cubic feet of gas; Texas No. 2, 34.2 cubic feet; North Dakota No. 2, 25.2 cubic feet; Colorado No. 1 (lignite), 42.1 cubic feet, and Wyoming No. 2 (lignite) 37 cubic feet, whereas one West Virginia coal yielded 70.1 cubic feet, another (West Virginia) 79.6 cubic feet, while the yield of the other bituminous coals ranged from 44.5 to 63.2 cubic feet.

But the economic results as shown by the horse power developed at the switchboard, and as calculated as available for effective use, are the striking features. In this we find that for each horse power per hour developed at the switchboard there were used of these lignites the following:—Colorado No. 1, 2.14 pounds; North Dakota No. 2, 3.8 pounds; Texas No. 1, 3.34 pounds; Texas No. 2, 2.58 pounds; Wyoming No. 2, 2.28 pounds. For effective horse power per hour, or that available for purposes outside of that used at the plant, the requirements would be:—of Colorado No. 1, 2.3 pounds; of North Dakota No. 2, 4.07 pounds; of Texas No. 1, 3.53 pounds; of Texas No. 2, 2.74 pounds, and of Wyoming No. 2, 2.49 pounds. How these compare with bituminous coals used under boilers is shown by the fact that the best West Virginia coal required 3.39 pounds per electrical horse power per hour at the switchboard, and of seventy-six tests under boilers, only five (all from West Virginia) required less than 3.5 pounds, and only twenty-six (fourteen from West Virginia) required less than 4 pounds of fuel. From this it appears that lignite coals, converted into gas and used in a gas-engine, will do equally as good service as the average bituminous coals used under boilers.

From the preceding tables some interesing comparisons can be drawn on the relative efficiency when used under boilers and in the gas producer, of such coals as had been subjected to both of these tests. As has already been explained it was not possible to make as many producer as steaming tests, and a number of coals have been tested in the producer since January 1, and after the other portions of the plant were shut down, the results of which tests are not yet worked up. Enough has been accomplished, however, to demonstrate the great advantage of the gas producer and gas engine over the boiler and steam engine, for the generation of power, and to substantiate the claims for economy made by the advocates of the gas engine. These facts are not entirely new, but their demonstration in official and unbiased tests is a matter worthy of record.



MECHANICAL INSTALLATION IN THE WASHERY BUILDING. THE UPPER PICTURE SHOWS THE STEWART JIG; THE LOWER, THE NEW CENTURY JIG.

COMPARATIVE
OF
LEADING RESULTS OF THE COAL TESTS

Name of Sample	Duration of Trials		Total Dry Coal Consumed per Hour		Dry Coal Burned per Sq. Ft. of Grate Surface per Hour	
	Steam Plant	Producer Gas Plant	Steam Plant	Producer‡ Gas Plant	Steam Plant	Producer† Gas Plant
	Hours	Hours	Pounds	Pounds	Pounds	Pounds
Alabama 2........	10.02	43.0	874	328.7	21.54	7.78
Colorado 1........	9.97	30.0	722	341.7	17.80	7.56
Illinois 3..........	10.13	30.0	861	356.7	21.23	8.41
Illinois 4..........	10.02	30.0	938	348.5	23.13	7.96
Indiana 1.........	9.93	29.67	908	384.3	22.39	9.08
Indiana 2.........	10.13	7.0	832	312.0	20.51	7.13
Indian Territory 1.	9.75	31.0	778	374.0	19.17	8.95
Kentucky 3........	10.07	30.0	882	381.2	21.75	8.92
Missouri 2........	9.98	4.33	1014	339.6	25.00	7.96
W. Virginia 1....	9.98	24.0	768	315.6	18.94	7.36
W. Virginia 4.....	10.00	9.0	770	258.2	18.98	5.96
W. Virginia 9.....	10.00	6.33	721	320.1	17.78	7.60
W. Virginia 12....	10.13	30.0	719	300.5	17.68	6.92
Wyoming 2.......	9.95	30.0	1075	416.5	26.51	9.50

During all the tests, as nearly as possible, the amount of energy delivered to the switchboard by both generators was 200 horse power. Both generators were direct-current, of 250 volts. The power was used in operating the plant and working exhibits in the "Mining Gulch," any surplus being consumed by two water rheostats placed just outside the engine room.

The table on this page and the one facing shows that in the production of this power the amount of coal consumed per hour under the boilers varied from 719 pounds of West Virginia high-grade bituminous, to 1,075 pounds of Wyoming black lignite, while in the gas producer the amount ranged from 258.2 pounds to 416.5 pounds, these two extremes being also made by West Virginia and Wyoming coals. It will be observed that in amount of coal consumed per hour, Colorado (a black lignite) was only a few pounds behind the best two West Virginia coals, but in evaporation results the lignites fell far below, and delivered only 149.1 horse power to the switchboard as compared with an average of over 200 for West Virginia coals.

The last three columns of the table show the amount of dry coal consumed per hour per electrical horse power delivered to the switchboard by the gas engine and steam engine, and the ratio between them. In every case the amount of coal consumed under the boilers was

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† Coal actually consumed in producer only.

‡ Includes coal consumed in producer, and coal equivalent of the steam used in the producer.

SUMMARY
THE
MADE UNDER THE BOILER AND IN THE PRODUCER

Water Evaporated from and at 212° F. per Pound of Dry Coal	B. T. U. per Pound of Dry Coal		Electrical H.-P. Delivered to Switchboard		Total Dry Coal per Electrical H.-P. per Hour		Ratio of Coal Consumption in Steam Plant to that in Producer Plant
Steam Plant	Steam Plant	Producer Gas Plant	Steam Plant	Producer Gas Plant	Steam Plant	Producer‡ Gas Plant	Pounds of Coal per Horsepower Hour
Pounds	B.T.U.	B.T.U.	E.H.P.	E.H.P.	Pounds	Pounds	
8.55	12,555	13,365	213.7	200.6	4.08	1.64	2.59 to 1
7.21	12,577	12,245	149.1	200.2	4.84	1.71	2.83 to 1
8.04	12,857	13,041	198.1	199.6	4.34	1.79*	2.425 to 1
7.27	12,459	12,834	195.4	198.4	4.80	1.76*	2.73 to 1
8.45	13,377	13,037	220.0	199.9	4.13	1.93*	2.14 to 1
8.02	.....	12,953	....	201.0	4.35	1.55*	......
8.64	12,834	13.455	192.3	204.0	4.04	1.83	2.21 to 1
8.27	13,036	13,226	208.9	200.5	4.22	1.91*	2.21 to 1
7.08	11,500	11,882	205.6	198.6	4.93	1.71*	2.88 to 1
8.95	14,198	14,396	196.7	200.4	3.90	1.57	2.48 to 1
9.65	14,002	14,202	212.5	199.7	3.62	1.29	2.81 to 1
10.09	14,616	14,580	208.2	201.0	3.46	1.59	2.176 to 1
9.90	15.170	14,825	203.6	199.8	3.53	1.50*	2.36 to 1
5.92	10,897	10,656	182.0	201.2	5.90	2.07	2.85 to 1

more than double that used in the gas producer, while in three instances it exceeded a ratio of 2.8 to 1. In one of the latter cases the hopper of the gas producer was leaking, and a considerable quantity of gas was lost. But for this the proportion would probably have shown a difference of 3 to 1.

It is to be remembered that the steam generated by the boiler was used in a simple, non-condensing engine of the Corliss type, whose "water rate" was 26.3 pounds of steam per hour per horse power developed; that this engine was belted to the electric generator; and that the mechanical efficiency of this combination of engine and generator was 81 per cent. With these figures available, it will be an easy matter to calculate the number of pounds of coal which would have been required to produce an electrical horse power, provided a more economical type of steam engine had been used, or if the electrical generator had been directly connected to the engine with the resulting advantage of a higher mechanical efficiency. If, for example, the steam generated had been used by a steam engine capable of generating one horse power with 18 pounds of steam per hour, and if the engine and generator had been direct-connected, giving as high a mechanical efficiency as 90 per cent., then the "Total Dry Coal per Electrical Horse Power per Hour" would have been re-

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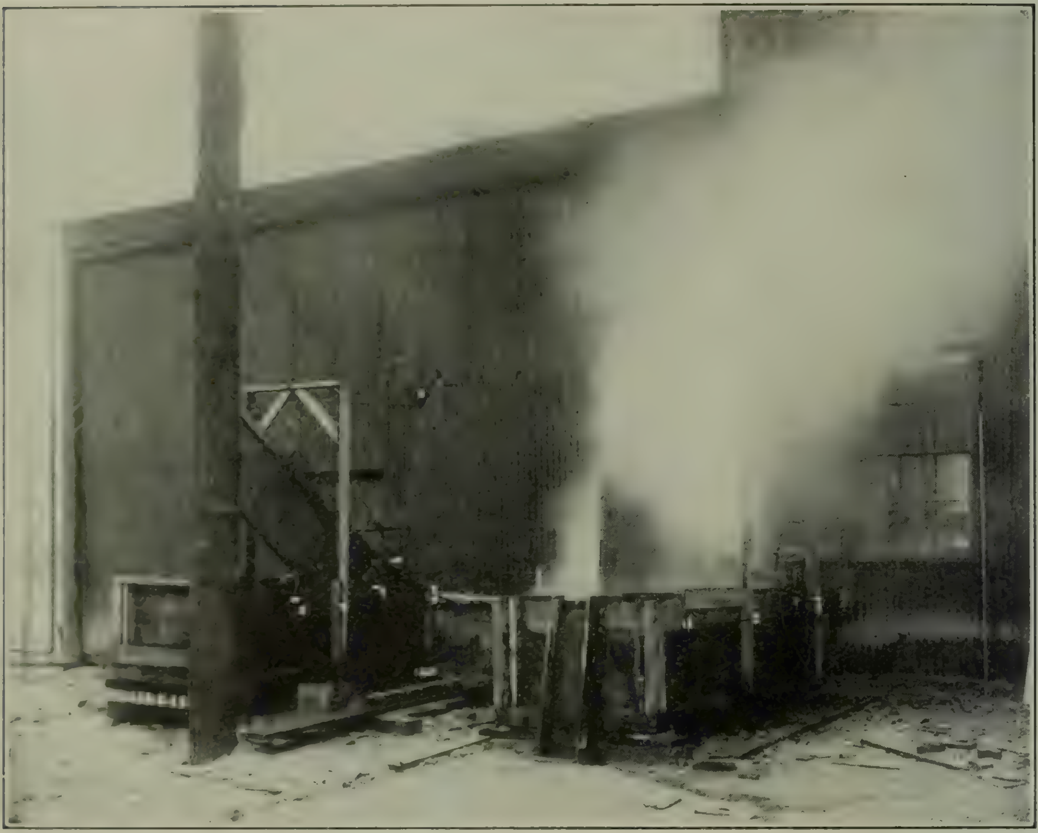
* Gas producer hopper leaked during these tests.

‡ Includes coal consumed in producer, and coal equivalent of steam used in producer.



THE WATER RHEOSTATS USED TO CONSUME THE SURPLUS OUTPUT OF THE GENERATORS IN THE COMPARATIVE TESTS OF GAS-PRODUCING AND STEAM-GENERATING VALUES OF VARIOUS COALS.

duced from 4.3 pounds, as given in column 13, to very nearly 3.0 pounds. While these figures are frequently and easily attained by steam engines operating in large units, it will be conceded that in plants of from 200 to 250 horse power they are seldom reached.

It should be mentioned that the labor required would be the same for the operation of either the boiler plant or the gas-producer plant of the capacity under tests. In either plant two men would be sufficient.

On the other hand, in considering the possible increase in efficiency of the boiler trials with a compound engine substituted for the simple engine used, the fact should not be overlooked that a corresponding increase in the efficiency of the gas-producer trials may be brought about under the most favorable conditions. The gas engine is passing through a transitional period. In the larger sizes, the vertical single-acting engine is being replaced by the horizontal double-acting. Other changes and improvements are constantly being made which tend to accomplish for the gas engine what compounding and tripling the expansions have already done for the steam engine.

The gas engine used in the trials recorded is a vertical three-cylinder, single-acting engine, with no means of changing the ignition while the engine is running. A brief consideration of these points will lead at once to the conclusion that the gas engine and steam engine used in these tests compare favorably, and that any increase in efficiency in the boiler trials that might result from using a compound engine can be offset by the introduction of the more modern type of gas engine.

Coking Tests.—The equipment provided for testing the coking qualities of the coals consisted of three beehive ovens of standard size—12 feet in diameter and 7 feet high—constructed from plans furnished by Mr. John Fulton, of Johnstown, Pa. It was the desire of the committee to have installed a battery of by-product-recovery retort ovens, but the construction of such a plant would have entailed the investment of between $50,000 and $100.000. It was not possible to secure this donation, but even if it had been furnished it is doubtful if the plant could have been constructed in time to have been put in blast prior to the close of the Exposition.

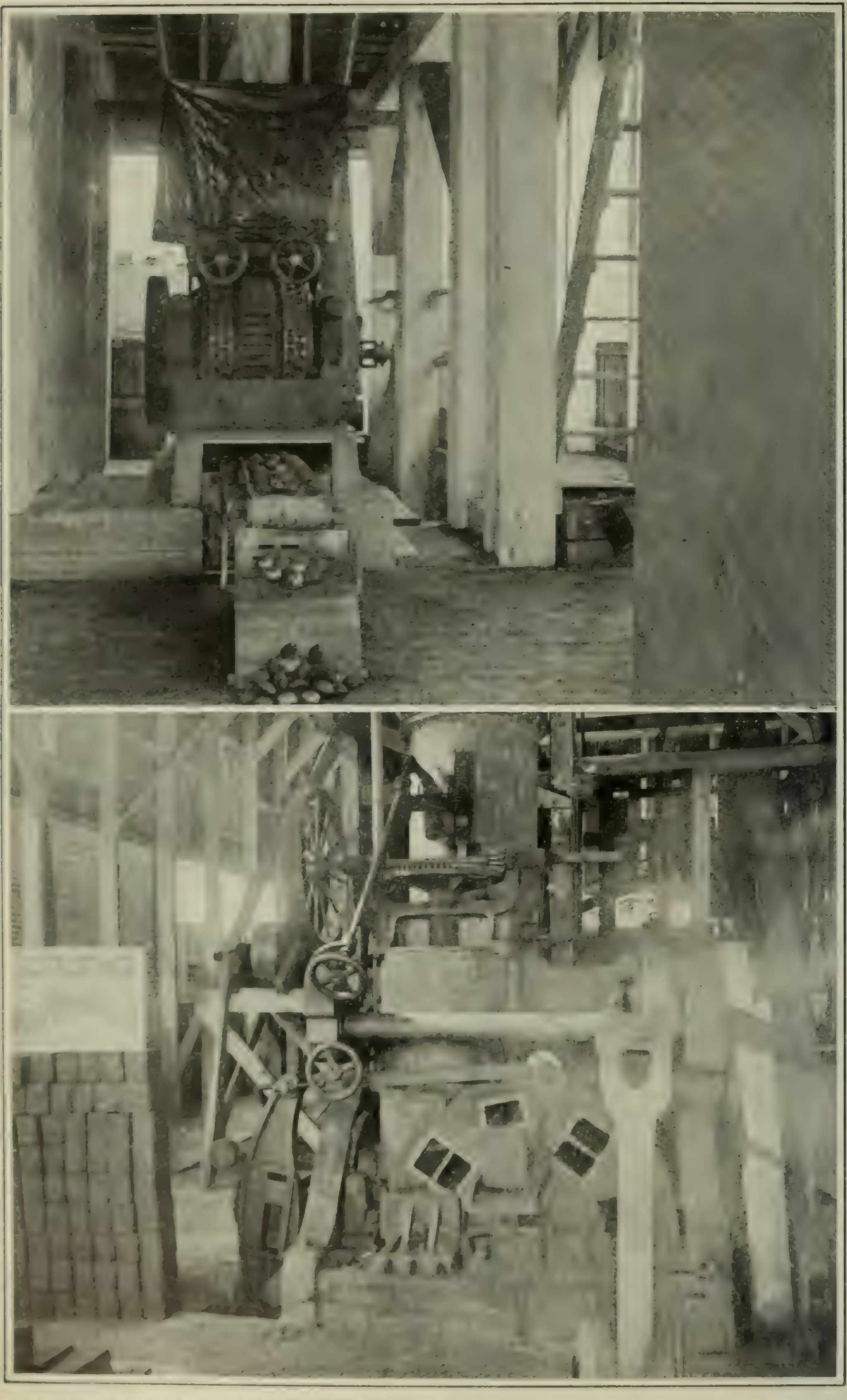
Tests in the beehive ovens were made with coals from all parts of the country, whether they had been previously considered as coking coals or not. Some of the coals were tested raw, some washed,

BRIQUETTING BUILDING NO. 1; BARTLETT-SNOW DRYER AT THE LEFT.

COKING TESTS.

Name of Sample.		Condition of Coal.	Chemical Composition of Coal.					Coal charged into oven. Pounds.	Coking time. Hours.	Coke produced. Pounds.	Breeze and ash. Pounds.	Chemical Composition of Coke.								Remarks.
			% Moisture.	% Volatile matter.	% Fixed carbon.	% Ash.	% Sulphur.					% Moisture.	% Volatile matter.	% Fixed carbon.	% Ash.	% Sulphur.	% Phosphorus.	Specific gravity.	Coke produced.	
Alabama	1	Raw	2.65	30.79	52.68	13.88	0.76	8000	88											Light, spongy.
Alabama	1	Washed	4.64	31.28	53.02	11.06	0.89	9800	65	5731	352	0.33	0.72	82.63	16.32	0.69	.047	1.94	58.5	Improved by washing.
Alabama	2	Raw	3.77	32.60	50.59	13.04	1.43	8000	64											Charred coal and ash remained.
Arkansas	1	Raw	2.31	18.10	66.58	13.01	1.13	8075	114											No coke produced.
Arkansas	2	Raw	2.31	17.41	69.73	10.55	1.58	8150	118											No coke produced.
Arkansas	6	Washed	18.29	12.95	62.54	6.22	1.22	9000	95											No coke produced.
Arkansas	3	Briq.						Small box	65			1.05	2.80	72.73	23.42	1.52				Placed in oven with charge of coal.
Arkansas	6	Briq.	4.59	17.25	64.12	14.04	1.68	8000	42	4056	539	4.06	2.77	76.63	16.54	1.43	.050	1.88	50.7	50% Briquettes and 50% coal charged.
Illinois	1	Raw	10.46	36.11	37.48	15.95	4.14	9000	43											Small coke and ash produced.
Illinois	2	Washed	17.20	35.77	37.84	9.19	3.03	9000	64	3389	352	1.57	2.83	75.42	20.18	2.75	.030	1.87	37.6	Hard and soft mixed.
Illinois	3	Raw	8.25	30.22	50.94	10.59	1.45	9000	43											No coke, burned on top.
Illinois	3	Washed	9.52	32.05	52.57	5.86	1.41	13000	90	6378	834	6.11	0.42	82.55	10.92	1.13	.019	1.84	49.1	Fingered, brittle.
Illinois	5A	Washed	17.86	31.65	32.93	17.56	3.25	8000	42											No coke produced.
Illinois	5B	Washed	25.15	28.68	36.99	9.18	2.71	5000	42											No coke produced.
Illinois	5C	Washed	14.60	30.76	36.48	18.16	3.44	9000	42											No coke produced.
Indiana	1	Washed	16.53	36.38	40.05	7.04	2.03	8000	40	3473	368	5.71	1.18	80.52	12.59	1.69	.016	1.86	43.4	Fair coke, brittle.
Indian Ter.	1	Raw	10.29	31.46	44.39	13.86	1.34	8095	40											Burned to ash.
Indian Ter.	2	Raw	3.82	37.45	48.74	9.99	1.47	9000	66	5725	580	8.15	1.74	75.68	14.43	1.50	.050	1.88	63.6	Coke soft.
Indian Ter.	2	Washed	4.45	38.18	51.04	6.33	1.43	9000	65	4680	255	0.96	2.59	85.33	11.12	1.75	.043	1.84	52.0	Coke hard.
Indian Ter.	3	Raw	4.16	36.66	49.43	9.75	3.16	12000	65											Small coke and ash produced.
Indian Ter.	3	Washed	5.93	38.05	48.53	7.49	3.20	14000	66											Not improved.
Indian Ter.	5	Washed	16.95	33.30	41.61	8.14	2.90	10000	65											Small coke, fritted.

Iowa	1	Washed	12.84	35.91	41.00	10.25	4.61	9500	46	4828	572	10.53	1.65	70.39	17.45	3.89	.051	1.87	50.7	Very brittle.
Iowa	2	Washed	12.85	35.44	35.43	10.28	3.93	10000	64	3866	1153								3.87	Sintered.
Iowa	3	Washed	16.83	39.27	35.87	8.03	4.55	8000	43	3336	585	5.73	1.87	75.49	16.91	4.57	.0183	1.88	41.7	Fine fingered.
Iowa	4	Washed	17.80	37.59	37.39	7.14	3.59	8000	40	3722	426	13.05	2.32	73.10	11.53	2.97	.0123	1.82	46.5	Fine fingered.
Iowa	5	Washed	19.25	31.07	41.75	7.93	2.28	9000	66											Charred coke and ash produced.
Kansas	1	Raw	8.10	31.26	45.82	14.84	4.48	11300	120											No coke produced.
Kansas	2	Raw	3.96	30.46	45.54	20.04	5.59	9125	159											No coke produced.
Kansas	3	Raw	1.75	32.95	48.39	16.91	5.60	7100	96											Coked 12″ from top.
Kansas	4	Raw	6.63	36.99	43.45	12.93	7.19	10000	67	5213	432	0.52	1.68	79.82	17.98	6.15	.0148	1.92	52.1	Hard and brittle.
Kentucky	1	Raw	2.71	37.22	56.17	3.90	1.23	10000	66	5441	355	1.48	0.83	92.34	5.35	0.84	.034	1.83	54.4	Hard, fine fingered.
Kentucky	2	Raw	8.66	32.45	41.13	17.76	4.04	9000	42											No coke produced.
Kentucky	3	Washed	10.51	37.33	44.76	7.40	2.51	10000	66	5433	426	0.14	0.56	86.31	12.99	2.16	.009	1.81	54.3	Fair coke.
Kentucky	4	Washed	6.18	39.07	48.70	6.05	2.74	10000	66	5528	313	0.52	0.63	86.50	12.35	2.37	.015	1.84	55.3	Good color.
Missouri	2	Washed	14.14	35.53	42.57	7.76	3.24	12000	87	5040	580	3.45	1.80	80.27	14.48	2.79	.02	1.86	42.0	Long fingered.
Missouri	3	Washed	24.15	33.10	35.51	7.24	2.74	9000	41											No coke produced.
Missouri	4	Raw	12.04	41.35	41.34	5.27	5.14	11000	65	4905	128	2.51	1.11	85.57	10.81	4.60	.018	1.83	44.6	Fair coke.
West Virginia	1	Raw	1.93	36.50	54.97	6.60	0.88	9000	64	5572	268	0.40	1.95	87.47	10.18	0.71	.029	1.84	61.9	Good coke.
West Virginia	2	Raw	1.73	39.20	50.85	8.22	3.38	9000	50	5235	286	0.42	0.68	83.95	14.95	3.40	.023	1.94	58.2	Gray, brittle.
West Virginia	2	Washed	3.98	39.76	49.21	7.05	2.84	13000	64	7808	302	0.59	1.31	86.70	11.40	2.24	.017	1.89	60.1	Improved by washing.
West Virginia	3	Raw	2.25	30.60	57.40	9.75	0.99	9000	41	5929	364	0.22	0.83	80.77	18.18	0.93	.065	1.95	65.9	Gray coke.
West Virginia	3	Washed	4.11	29.54	57.34	9.01	1.18	14000	66	9070	535	0.38	0.87	84.48	14.27	1.19	.079	1.94	64.8	Not improved by washing.
West Virginia	4	Raw	2.72	27.62	59.16	10.50	0.86	12000	65	8907	428	0.62	1.43	86.10	11.85	0.82	.031	1.84	74.2	Good coke.
West Virginia	4	Washed	3.47	27.95	61.05	7.53	0.74	9000	42	6367	374	0.20	1.15	85.42	13.23	0.69	.019	1.94	70.7	Not improved by washing.
West Virginia	5	Raw	2.43	28.30	58.55	10.73	0.90	13000	64	8298	497	2.60	1.12	77.14	19.14	0.77	.067	1.90	63.8	Good coke; too much ash.
West Virginia	5	Washed	4.84	28.12	56.76	10.28	0.91	13000	66	7163	461	0.42	0.43	84.34	14.81	0.83	.086	1.89	55.1	Improved by washing.
West Virginia	5	Washed, fine	19.50	23.76	48.55	8.19	0.79	10000	69	4256	229	0.27	0.78	82.97	15.98	0.82	.087	1.89	42.5	Improved by washing; fine coal.
West Virginia	6A	Raw	1.76	21.48	71.92	4.84	0.55	13000	90	8303	381	2.83	2.17	89.84	5.16	0.69	.008	1.77	63.9	Gray, soft and light.
West Virginia	6B	Raw	2.27	22.03	70.30	5.40	0.88	9000	66	6399	382	0.36	1.34	93.04	5.24	0.76	.007	1.87	71.1	Better than A.
West Virginia	6C	Raw, fine	1.73	21.12	71.57	5.58	0.64	8000	44	5849	273	1.89	1.83	88.80	7.48	0.69	.006	1.79	73.1	Dense, tough.
West Virginia	7	Raw	3.85	20.55	70.58	5.02	1.36	8000	44	5119	287	0.67	1.23	90.40	7.70	1.03	.0061	1.80	64.0	Good coke.
West Virginia	8	Raw	3.82	31.77	57.21	7.20	0.89	9000	66	7124	589	2.79	0.53	82.37	14.31	0.77	.0116	1.92	79.2	Hard, good color.
West Virginia	9	Raw	3.81	31.08	57.04	8.07	0.83	8000	40	6084	314	0.29	2.41	88.15	9.15	0.82	.0094	1.84	76.0	Fair coke, heavy.
West Virginia	9	Washed	5.74	32.14	57.61	4.51	0.90	11000	66	6803	78	0.27	0.62	91.73	7.38	0.77	.012	1.87	61.8	Very good coke.
West Virginia	10	Raw	1.61	18.39	74.65	5.37	0.61	11000	63	7858	429	3.68	0.53	87.54	8.25	0.56	.007	1.89	71.4	Good coke.
West Virginia	11	Raw	3.35	15.94	68.76	9.95	0.47	11000	67											Burned to ash.
West Virginia	12	Raw	1.53	18.23	71.08	6.16	0.97	11000	68	7082	549	0.35	0.85	89.37	9.43	0.83	.0077	1.95	64.4	Fair coke.
West Virginia	12	Washed	8.36	18.20	68.54	4.90	1.11	8000	44	5050	583	5.16	0.72	86.57	7.55	1.01	.01	1.88	63.1	Large pieces.



THE UPPER PICTURE SHOWS THE EGGETTE MACHINE, MADE BY THE NATIONAL COMPRESSED FUEL CO.; THE LOWER, WM. JOHNSON & SONS' BRIQUETTING MACHINE.

and some both raw and washed. All coal charged into the ovens was first crushed in rolls to 1½ inches in size or smaller. There were altogether fifty-nine coking tests, for which only thirty-seven, or 63 per cent., produced coke of sufficiently good quality to sample for chemical analysis. One or two tests were made on non-coking coals with an added mixture of pitch or coal tar, with the result that a fair grade of coke was produced, encouraging some further investigations along these lines.

The results of the coking tests are summarized in the tables presented on the two pages preceding (*222* and *223*).

Briquetting Tests.—The equipment provided for carrying on the experiments relating to the briquetting of coals consisted of two machines of distinctly different types. One of these was furnished by William Johnson & Sons, of Leeds, England, of which the briquetting portion consisted of a double-compression, vertical-table press, with closed molds. It is designed for using stiff coal-tar pitch. The other briquetting machine was furnished as an exhibit by the National Compressed Fuel Company, of Chicago. It was built by the Chisholm, Boyd & White Company, on the Belgian pattern, in which the briquettes, or, more properly speaking, eggettes, were compressed in ovoid cups on the tores of narrow-faced rolls. As the rolls revolve, face to face, the excess material is squeezed out, the resulting pressure being dependent upon the viscosity of the mixture. The eggettes, which were something larger than a goose egg in size, weighed about three-tenths of a pound each. The capacity of each press was about 5 tons of eggettes or briquettes per hour, when running at full capacity. The briquettes from the English machine were rectangular and weighed from 5⅛ to 7¼ pounds, according to the character of the coal from which they were made. The American machine had the advantage of being adapted for the use of soft, or liquid, binding materials. The English machine, however, could only be used with stiff pitch, or similar material.

A large amount of experimental work was done on a laboratory scale with different binding materials, before they were tried on a commercial scale with the machines. The binding materials upon which this laboratory work was done consisted of pitch of various grades, creosote, asphalt (hard and soft, crude and refined), asphaltic pitch, petroleum (both of paraffine and asphalt basis), molasses, rosin, lime, and clay.

In the following table are given proximate analyses of the different pitches which are used in the briquetting of coals in the English machine. The letters, A, B, C, etc., are used to indicate the pitch used in the summary of briquetting tests, which is given later. All of the coal-tar pitches used were furnished by the Barrett Manufacturing Company, of St. Louis, or the Chatfield Manufacturing Company, of Carthage, Ohio. Pitches A, B, C, and D were supplied by the Barrett Manufacturing Company; E, F, G, and X, by the Chatfield Manufacturing Company. Pitch H was also furnished by the Barrett Manufacturing Company and was the product of the manufacture of gas from heavy petroleum:—

PROXIMATE ANALYSES OF PITCHES.

Pitch.	Laboratory No.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Total.
A	1161	0.47	47.93	50.79	0.81	*0.80	100.80
B	1311	1.14	49.66	47.88	1.32	.70	100.70
C	1391	.88	62.75	35.84	.53	....	100.00
D	1465	1.45	54.05	43.91	.59	....	100.00
E	1464	1.02	54.11	44.04	.83	....	100.00
F	1457	.57	52.98	45.31	1.14	....	100.00
G	1453	.60	52.53	45.62	1.25	....	100.00
H	1555	1.04	61.44	36.72	.80	....	100.00
X	1125	.33	59.07	39.44	1.16	.88	101.38

Only the cheaper grades of rosin were used and they were found to be as good for this purpose as more refined material.

Asphaltic Binders.—The asphalts used in this experimental work were achieved from widely different localities. These binding materials are designated in the subsequent table as B1, B2, etc., from the following sources:—B1, California refined asphaltum, grade B. B2, rubbery asphalt product, manufactured by the Raven Mining Company, of Texas, known as "kopak" No. 30. B3, asphalt pitch, manufactured by the Standard Oil Company at one of its Texas plants. B4, crude asphalt from the Indian Territory. B5, a soft asphalt from the Gulf Refining Company, of Texas; and B6, soft asphalt, furnished by Mr. John McNeil, from Casper, Wyoming.

Petroleum Binders.—On account of the short time available for the experimental work that was necessary in the use of petroleum as a binding material, this work was limited to laboratory experiments. It was found that most of them were too fluid and had little or no binding qualities when used alone, and could only be satisfactorily used with rosin or hard pitch.

Briquettes Manufactured.—After the laboratory experiments had demonstrated that investigations were worth continuing on a commercial scale, the briquettes were made in quantities, on either the

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* Approximately determined.

American or English machine, according to the type of binder that had been used in the laboratory experiments. If the laboratory work showed that coals could not be briquetted except by using so much binding material that the increased cost was excessive, it was not considered advisable to continue the investigation on a larger scale. The number of "runs" made in the briquetting machines were twenty-seven. These were distributed as follows:—

One from Alabama, six from Arkansas, one from Colorado, two from Illinois, two from Indiana, three from Indian Territory, one from Iowa, one from Kansas, two from Kentucky, one from Missouri, one from Montana, two from New Mexico, one from North Dakota (lignite), one from Pennsylvania (anthracite culm), one from West Virginia, and one from Wyoming. There were four grades of coal which offered special opportunities for the application of briquetting processes. These were (1) the Pennsylvania anthracite culm, (2) the slack coal from the dry non-coking bituminous coal of the Mississippi Valley, and which is now either thrown on the slack pile and burned, or sold for practically nothing, (3) the fine coal produced in the mining of semi-anthracite coals of Arkansas and the Indian Territory, (4) the brown lignites. The experiments with the first three were generally highly successful, but little progress was made in the utilization by this means of the brown lignite coals. The high percentage of moisture contained therein, and the fact developed in the course of the investigation—that it was impossible to dry out this moisture without setting up the distillation of the lignite itself—has made it impossible with the means at hand to successfully briquette and improve the quality of this product. Enough has been done, however, to show that further investigations along these lines are highly desirable.

Experiments in the briquetting of coke breeze, and also that of anthracite culm, with a small percentage of bituminous coke, coal and pitch, have resulted very satisfactorily. It was also found that a fair degree of coke could be made of non-coking coals which had been mixed with pitch and then passed through the briquetting machines.

The results of the twenty-seven tests that were made on a commercial scale were as shown in the tables on pages 228 and 229. With their presentation this brief synopsis of the work done at the station during its first period of operation must close. The appropriation lately made by Congress for the continuation of the tests, it may be confidently expected, will enable much more and more valuable work to be done in the immediate future.

SUMMARY OF BRIQUETTING TESTS.

COAL						BINDER					BRIQUETTES					
		Chemical composition							Composition							
Name of sample	Character	Volatile matter	Fixed carbon	Moisture	Ash	Specific gravity	Per cent.	Kind	Volatile matter	Fixed carbon	Specific gravity	Weight in pounds	General character	Behavior on weathering	Behavior on burning	Crushing strength
Alabama No. 1		31.84	53.28	2.34	12.54		7	Pitch A	47.93	50.79		5.12	Good	Slightly disintegrates	Good	
							9.25	Pitch A								
Arkansas No. 1		17.46	66.69	3.24	12.61		11	Pitch X	59.07	39.44			Poor, friable	Disintegrates	Poor	
Arkansas No. 2		16.02	72.55	2.23	9.20		9.5	Pitch X				6.8	Poor, porous	Poor		
Arkansas No. 3	Slightly moist	19.47	66.71	2.19	11.63		8.7	Pitch A								
do	do												Very good, smooth & hard	Good	Held together until consumed	
Arkansas No. 4	Slack					1.35	12	Pitch X					Incoherent	Disintegrates		
do	do					1.35	10	Pitch A				6.47	Good compact	Good		
do	do					1.35	3 2	Rosin Pitch A				6.87	Clean, compact but brittle	Good	Some smoke Very good	
do	do					1.35	3 3	Rosin Pitch A			1.13	6.87	Clean excellent	Good	Burn readily	
do	do					1.35	6	Pitch B	49.66	47.88	1.17	6.92	Excellent in every respect	No deterioration	No disintegration	8780
do	do	12.82	73.69	1.28	12.21	1.35	3 2	Rosin Pitch B				7.20	Tender, friable		No disintegration	17500
Colorado No. 1		34.88	40.45	18.68	5.99		10	Pitch D	54.05	43.91		5.98	Hard and lustrous, but brittle	Slight deterioration	Satisfactory, little disintegration	
Illinois No. 1	Soft	37.48	39.57	9.75	13.20		16	Pitch X					Like pressed damp loam			
Illinois No. 4		31.90	43.55	12.91	11.64	1.34	6	Pitch D			1.16	6.95	Hard, but rather friable		Some disintegration	5100
do						1.34	8	Pitch D			1.11	6.43	Hard and tough	Good	Good	9327
do	Coarse					1.34	8	Pitch E	54.11	44.04	1.13	6.15	Not well pressed Somewhat porous		Fair	7266
do	Fine					1.34	8	Pitch E			1.03	6.50	Well pressed but friable	Fair	Fair	6000
do						1.34	9	Pitch E			1.08	6.43	Good	Fair	Good	9125
do						1.34	8	Pitch H			1.11	6.81	Clean. Excellent	Good	Very satisfactory	12810
do						1.34		Asphalt B4				6.77	Tough. Fair			
Indiana No. 1	Washed						7	Pitch D				6.80	Very good	Good	Very satisfactory	
Indiana No. 2		36.14	41.22	9.62	13.02		7	Pitch H				6.42	Clean, excellent	Good	Very satisfactory	

Ind. Ter. No. 2	Hard	36.15	48.40	4.45	11.00		13.4	Pitch X				6.15	Poor	Crumbled	Poor	
Ind. Ter. No. 3		37.00	47.25	4.61	11.14		8	Pitch A				6.56	Fair	Disintegrates	Fair	
Ind. Ter. No. 6	Dirty slack	31.28	41.40	8.03	19.29		7	Pitch D			1.205	7.35	Dense but crumbly	do	Disintegrates	5600
do	do						9	Pitch D				7.50	do do	do	do	
do	do						8	Pitch A					do do	do	do	
do	do						6 1	Rosin Lime				7.00	do do	do	do	
do	do						6 1	Rosin Petroleum P3			1.25	7.29	Strong, good		Good	6400
do	do						8 1¼	Pitch Creoso'			1.215	7.25	Good, crumbles slightly		Good	6500
do	do						8	Aspha [illegible]	80.75	19.25	1.22	7.12	Tough, good		Good	3200
do	do						8	Pitch H	61.44	36.72		7.27	Very good		Very good	
Iowa No. 4		35.59	39.37	14.08	10.96		7	Pitch E				6.73	Crumbled	Poor	Fair	
do							8	Pitch E				6.77	Strong	Good	Very good.	
Kansas No. 2		31.23	46.68	4.18	17.91		11	Pitch X					Poor	Poor	Poor	
Kentucky No. 1	Good coking	36.12	56.39	3.10	4.39		6	Pitch D				6.15	Good, slightly porous	Very good	Excellent	
Kentucky No. 2	Rather hard	37.94	45.02	7.91	9.13	1.37	9	Pitch E				6.83	Very hard	do	do	
do	Slack					1.37	8	Pitch E			1.13	6.83	Excellent	do	do	11300
Missouri No. 1	Washed	33.58	38.73	8.33	19.36		11.5	Pitch A					Pitch set too quick; porous	Fair	Good	
Montana No. 1	Washed	35.90	42.08	11.05	10.97		16	Pitch A				6.30	Fair, rather porous	Good	do	
do	do						7	Pitch B				7.00	Hard but brittle	do	do	
New Mex. No. 1		34.58	46.14	12.29	6.99		12	Pitch A					Very unsatisfactory	Crumbles	Disintegrates	
do							15.8	Pitch X					Poor	do	do	
do							8	Pitch D			1.13	6.83	Fair	do	do	7120
do							10	Pitch D			1.02	6.42	do do	do	do	5900
do							8	Pitch H			1.06	6.25	Hard and strong	Good	Good	13050
New Mex. No. 2	Slack	33.82	36.73	10.79	18.66		7	Pitch D				7.00	Crumbly	Disintegrates	Disintegrates	
do	do						9	Pitch D				7.12	Earthy	Fair	Fair	
N. Dak. No. 1	Tough. Not dry	29.59	25.68	35.38	9.35		10	Pitch A					Porous, little cohesion	Disintegrates	Disintegrates	
do	Dry						12	Pitch A					do	do	do	
Penn. No. 3	Anthracite culm	7.02	71.79	5.41	15.78	1.52	12.5	Pitch A 11 parts W. Va. coal				7.25	Hard and tough Good	Become pitted	Good, like anthracite	
do	do 84%					1.52	7 9	Pitch B W. Va. coal			1.174	7.64	Fair	do	do	4500
do	do dried					1.52	7	Pitch B			1.28	7.40	Hard and strong	Good	do	17190
West Va. No. 6							5	Pitch Y				6.12	do	Very good	Very good	
do							3	Pitch Y					Good	Good	Good	
Wyoming No. 1		35.68	37.19	22.63	4.50		9	Pitch H				6.31	Fair, porous	Fair	Sat'f'y	
do	Dried					1.16	8	Pitch H			0.98	5.85	When cold hard	Good	Good	9600
do	do					1.16	5 2½ 1	Asphalt B6 Rosin Lime		78.77	29.75	5.40	Poor	Fair	Fell to pieces	
Arkansas No. 5		12.68	72.88	2.36	12.08			Pitch C								
Arkansas No. 6		13.89	38.50	3.80	13.81		8	Pitch A								

THE EFFECTS OF VACUUM ON STEAM-ENGINE ECONOMY.

By R. M. Neilson.

Mr. Neilson's two preceding articles dealt with, first, the means for the superheating of steam, and second, the influence of superheating on engine economy. The article now presented takes up the general aspects of the economy of condensing; a following one will discuss types of condensers and allied apparatus.—The Editors.

THE usefulness of a vacuum for a steam engine was known at a very early age. The Newcomen engine, which may be said to be the first engine to be usefully employed, was absolutely dependent on the existence of a vacuum. In fact, it has been asserted that the Newcomen engine should be called an atmospheric engine or a vacuum engine instead of a steam engine. Up till about 1840 the steam pressures used with condensing engines were usually so small that the reduction in back pressure due to condensing had a very great influence on the effective pressure on the piston. As higher steam pressures came into vogue, the absence of a condenser made less difference to the power of an engine; but it was recognized that condensing had the advantage of allowing a greater amount of useful work to be obtained from a given quantity of steam. It then became a serious question to consider in any case whether this gain was sufficient to pay for the condensing plant and the condensing water; and ever since then this question has demanded a consideration by steam-engine users.

In Figure 1 the area ACD denotes the work done by one pound of steam at a pressure of 200 pounds per square inch absolute, in expanding adiabatically to a pressure of 1½ pounds absolute, (which corresponds to a vacuum of about 27 inches of mercury, when the barometer is at 30 inches) and exhausting at this pressure. If the expansion had been carried only to a pressure of 15 pounds absolute, that is, just above normal atmospheric pressure, the work would be represented by the area ABE.

It is convenient in comparing the work done by steam in expanding to different pressures to consider, not only the work done by the steam when expanding, but also the work done when its pressure is usefully employed before it expands—that is, in the case of a piston engine, the work done before cut-off. We then get the work actually obtainable from the steam when expanding to and exhausting at a given pressure. This work in the case of one pound of steam at 200 pounds absolute, expanding adiabatically to and exhausting at a pressure of 1½ pounds absolute, is represented by the area FACK and amounts to 244,000 foot pounds. The corresponding work when the expansion is carried only to 15 pounds absolute is represented by the area FABH and amounts to 146,000 foot pounds. This shows the enormous amount of additional heat energy converted into mechanical work when the steam is expanded from atmospheric to a very low pressure. This additional work would have been still greater if the expansion had been carried further. If, for example, the expansion had been carried to an absolute pressure of 0.6 pound, (which corresponds to a vacuum of 28.78 inches of mercury when the barometer is at 30 inches) the total work obtainable from the steam would have amounted to 278,000 foot pounds.

When the point B is reached on the expansion curve, 14.1 per cent. of the steam will have condensed; when the point C is reached, 22.6 per cent. of the steam will have condensed; and if the expansion curve were continued till the pressure was 0.6 pounds absolute, the amount of steam condensed would be 25.5 per cent. This of course refers to adiabatic expansion. Much more steam may be condensed if heat is given by the steam to the walls of the vessel in which the expansion takes place.

The actual advantage obtained in practice by condensing is not so great as is indicated in a diagram such as Figure 1. This is because the losses in a condensing engine are proportionately greater than in a non-condensing engine. That is to say, when the area ACD represents the

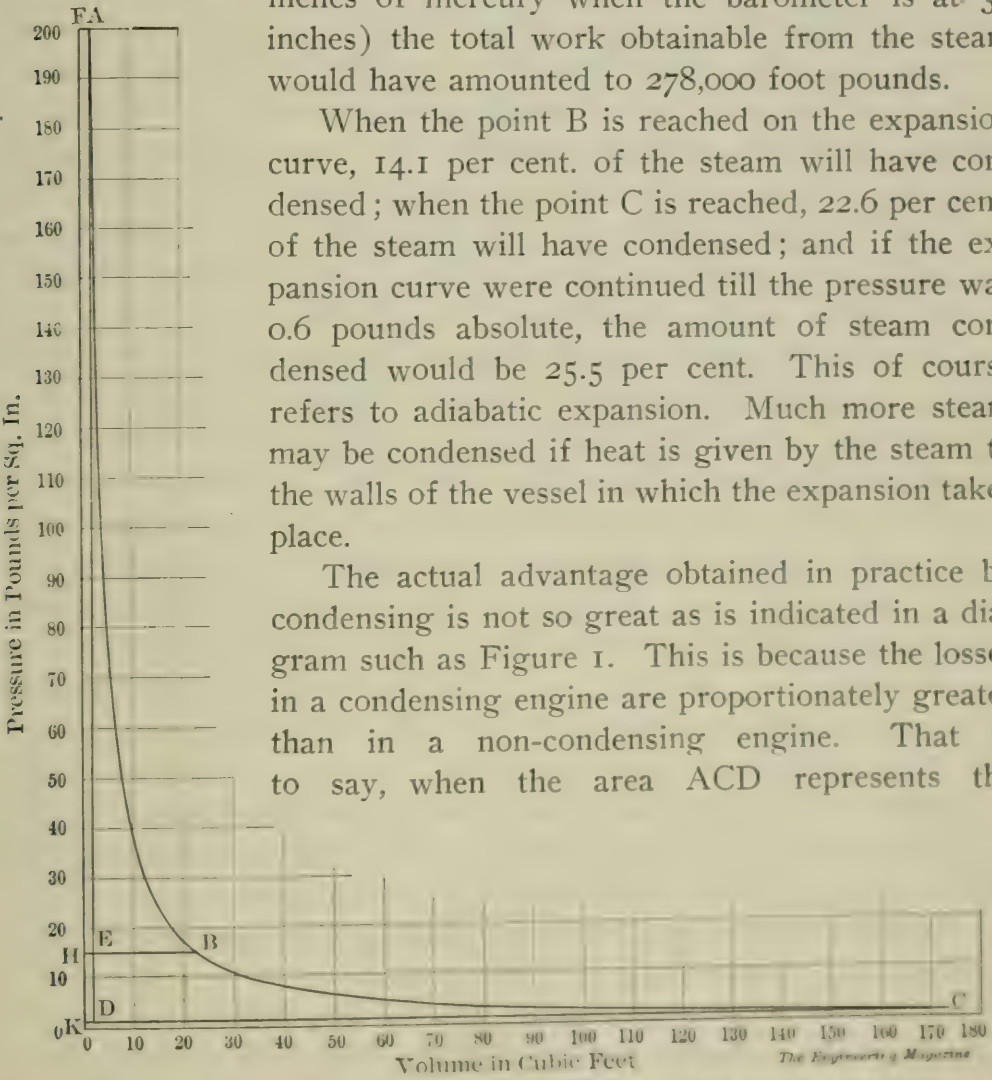

FIG. 1. DIAGRAM SHOWING THE WORK DONE BY STEAM EXPANDING ADIABATICALLY.

amount of work obtainable from an ideal engine, a smaller fraction of this is converted into useful work than when the area ABE represents the work obtainable from an ideal engine. This statement is true to a greater extent with reciprocating engines than with turbines. That is to say, condensing makes more difference in the economy of a turbine than in the economy of a reciprocating engine. This is for two reasons. In the first place it is not practicable for a reciprocating engine to expand to a very low pressure, such as to that given by a good condensing plant—the dimensions of the cylinder (the low-pressure cylinder, if a multiple-expansion engine) would be far too great; and, besides the excessive bulk, weight, and initial cost, the friction which the use of such a cylinder would involve would far more than outweigh the advantage gained by its use. For example, if steam at 200-pounds pressure absolute were expanded adiabatically to a pressure of 0.6 pounds absolute in a reciprocating engine, it would require a cylinder 6½-feet diameter and 12-feet stroke to deal with a single pound of steam per stroke. If the engine were a multiple-expansion one, these dimensions would represent the size of the low-pressure cylinder. A turbine, on the other hand, can without any practical difficulty and without the necessity of huge dimensions be made to expand the steam almost to the pressure in the condenser.

The other reason for the relatively greater gain of the turbine than the reciprocating engine by condensing results from the waste of steam in reciprocating engines through initial condensation and through leakage past valves. How much of the loss is to be attributed to initial condensation and how much to leakage past valves is a question about which there is much difference of opinion; but that a waste does occur is proved without doubt by the indicator diagram accounting for a much less weight of steam than is obtained by condensing and weighing the exhaust from the engine, and this when precautions have been taken to ensure that the steam enters the valve chest dry.

These causes prevent a reciprocating engine from benefiting from a good vacuum to the same extent as a turbine, or to anything like the extent to which it is thermodynamically entitled.

An objection to a high vacuum which acts equally against reciprocating and turbine engines is the lower temperature of the water in the hot well. If the water is pumped direct from the hot well into the boiler, then the hotter it is, the less coal will be required to generate steam. Although this objection acts equally against reciprocating and turbine engines, the disadvantage with regard to the latter is almost insignificant in comparison with the benefits obtained from the increased expansion. The case is however different with the reciprocating engine, with which the question of temperature of feed water requires careful consideration. In cases where an economiser is employed in conjunction with a reciprocating engine and a boiler, and where there is always ample heat in the waste gases from the boiler to heat the feed water, the reduction of the temperature of the hot well becomes unimportant.

It is generally admitted that the vacuum which is most beneficial to a reciprocating engine is about 24 to 26 inches of mercury when the barometer is at 30 inches; with a better vacuum the additional gains are eaten up by the additional losses. Of course, the exact figure in the case of any engine depends on the size and type of engine, the conditions under which it is worked, the nature of the condensing plant, the temperature of the cooling water, etc.

It has been asserted by Mr. Alfred Saxon* that a reciprocating engine, when working at full load, can benefit by a better vacuum than when working at light load. This seems reasonable, as the additional gains due to increase of vacuum will be less per revolution of the engine at light load than at full load, while the additional losses due to the same will be practically the same at both loads. The point where the gains just equal the losses will therefore occur at a poorer vacuum at light load than at full load. This would seem to show that when a condensing engine is run with a widely varying load with a regular diurnal period, and when a cooling tank is employed to allow the same condensing water to be used over and over again, it would be advantageous in many cases to run the engine non-condensing at light loads in order to allow the water to cool and thus have it in better condition for producing a fairly good vacuum when the engine is running at full load.

Steam turbines are usually chosen for use in power stations on account of their economy when run condensing. When deciding whether to install turbine or reciprocating engines in a power station, it is therefore important to make certain that a cheap and plentiful supply of condensing water will be available not only at the time of the installation of the plant, but at all future times as far as can be foreseen.

Turbines benefit very much by condensing. Condensing steam turbines have a very much lower steam consumption than non-con-

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* Manchester Association of Engineers, Nov. 28, 1903.

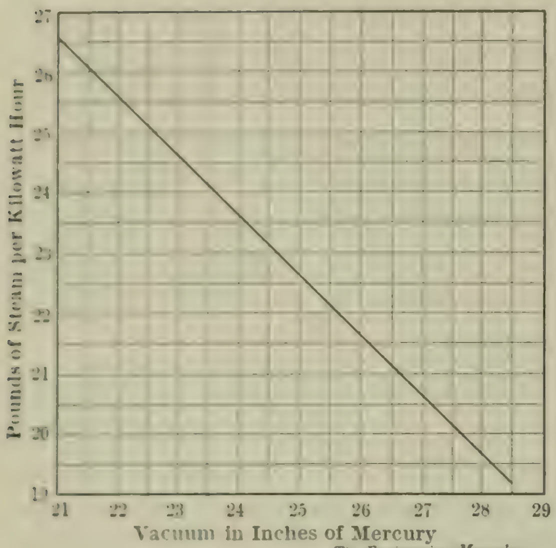

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FIG. 2. STEAM CONSUMPTION IN POUNDS PER KILOWATT HOUR OF A 600-KILOWATT CURTIS STEAM TURBINE AT FULL LOAD WITH VARYING VACUUM.

densing steam turbines of the same type and power and supplied with steam at the same temperature and pressure. A steam turbine which with a good vacuum has a higher efficiency than a reciprocating engine working at the vacuum which suits it best, may make a very poor show compared with the reciprocating engine when both are working non-condensing. A turbine wants the best vacuum it can get; and an increase of vacuum from 27 inches of mercury to 29 inches when the barometer is at 30 inches should very considerably reduce the steam consumption.

Tables I and II and Figures 2 and 3 show the effect of vacuum on the steam consumption of steam turbines.

Table I has reference to a turbine built by Messrs. C. A. Parsons & Co. of Newcastle-on-Tyne.

It will be seen that in this test every aditional inch of vacuum has reduced the steam consumption by about 4 per cent. (rather more than one-quarter load).

TABLE I. STEAM CONSUMPTION OF 500-KILOWATT PARSONS TURBO-ALTERNATOR RUNNING AT 2,500 REVOLUTIONS WITH 140 LBS. STEAM PRESSURE AT THE STOP VALVE AND NO SUPERHEAT. (BASED ON RESULTS OF TESTS.)

Vacuum constant from full load to no load. Inches of mercury.	Consumption of steam per kilowatt hour.			Consumption per hour.
	Full load.	Half load.	Quarter load.	No load.
29	....	....	....	1500
28	22.2	25.6	32.4	1700
27	23.1	26.9	34.5	1900
26	24.0	28.2	36.6	2100
25	25.1	29.7	39.0	2300
24	26.2	31.2	41.2	2500
23	27.5	32.9	44.8	2700
22	28.9	34.7	46.3	2900

Table II refers to a 1,500-kilowatt turbine built by the Westinghouse Machine Company.

It will be seen that an increase of 1¼ inches of vacuum (allowing for the difference in the barometer) reduces the steam consumption nearly 8 per cent. (The slight increase in the superheat of the steam in the second test will do more than compensate for the reduction in the load.)

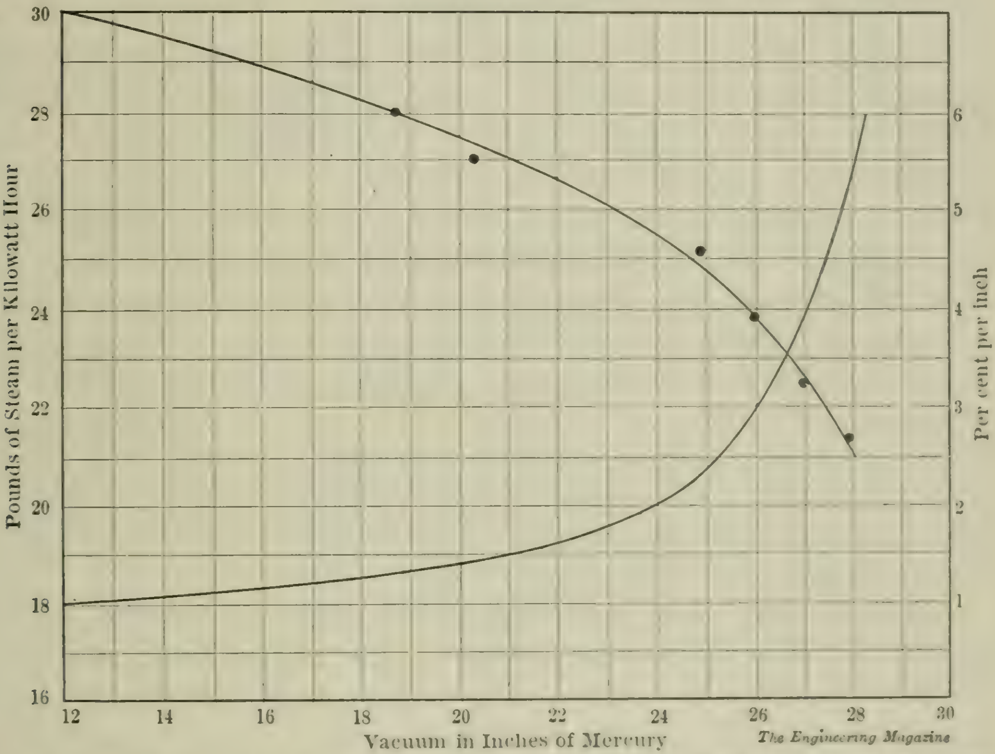

FIG. 3. EFFECT OF CHANGE OF VACUUM ON THE EFFICIENCY OF A PARSONS TURBINE.

TABLE II. TESTS OF 1,500-KILOWATT WESTINGHOUSE-PARSONS TURBO-GENERATOR AT HARTFORD, CONN., U. S. A.*

Average load in kilowatts.	Length of test in hours.	Steam-gauge press. in lbs. per sq. in.	Superheat degrees F. (mean).	Barometer in inches of mercury.	Vacuum in in. of mercury.	Steam consumption. Lbs. per kilowatt hour.
888	6	152.6	32.9	30.04	25.83	26.53
834	6	153.2	35.4	30.26	27.26	24.60

Figure 3 illustrates well how the efficiency of a turbine of the Parsons type is affected by change in degree of vacuum. The curve which is concave downwards shows the consumption of steam per kilowatt hour with different degrees of vacuum. The dots represent the measured consumptions from which the curve was drawn. The other curve shows the percentage increase of efficiency or reduction of steam consumption per inch of increase of vacuum at different

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* The Steam Turbine, by R. M. Neilson. Longmans & Co.

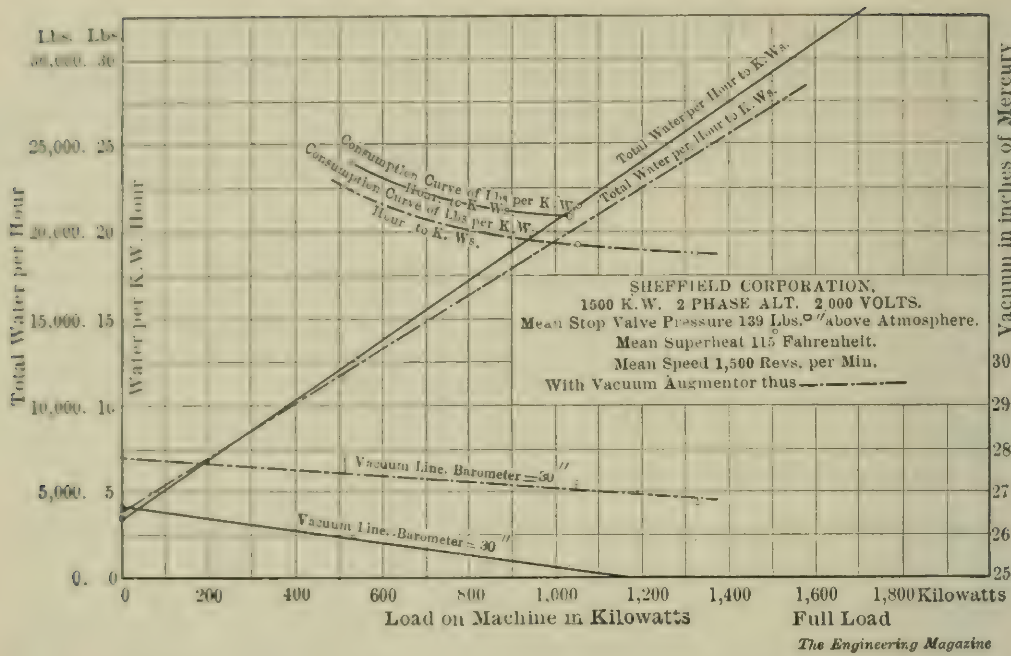

FIG. 3 A. SHOWING THE EFFECT OF A PARSONS VACUUM AUGMENTOR IN IMPROVING THE VACUUM AND REDUCING THE STEAM CONSUMPTION OF A STEAM TURBINE.

vacua.* Large Parsons turbines seem to benefit rather more than small ones from an improvement in the vacuum.

Figure 2 shows how a change in the degree of vacuum affects the efficiency of a Curtis steam turbine. The line of steam consumption per kilowatt hour with varying vacuum is almost straight; and tests of other Curtis turbines have given a line of equal straightness. Each additional inch of vacuum between 21 inches and 24 inches reduces the steam consumption about 4 per cent., and every additional inch between 26 and 29 reduces the steam consumption about 5 or 6 per cent. Figure 3A shows the effect of increased vacuum on a steam turbine; but the chain-line curves which indicate the steam consumption with the higher vacuum include the steam consumption of an augmentor used to improve the vacuum, as will be described later. Ignoring the means employed to obtain the vacuum, the turbine therefore in this case gains more by increase of vacuum, especially at light loads, than is evident from the figure.

Of course, if a turbine is to benefit by having a good vacuum in the condenser, we must see that the exhaust steam from the turbine has an easy passage to the condenser; and as with a good vacuum we are dealing with very large volumes and very low pressures, we must have the exhaust pipe of large sectional area and as short as possible. This is done in practice as far as practicable. The exhaust pipes of condensing steam turbines are usually of a sectional area very much in excess of that which is usual with condensing reciprocating engines. For example, the exhaust pipe of the Parsons 1,000-kilowatt steam turbine at the Close Works of the Newcastle and District Electric Lighting Company is 3 feet in diameter.

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* Paper read by William Chilton before the Manchester Section of the Institution of Electrical Engineers, Feb. 2, 1904.

In order that the exhaust pipe may be as short as possible, it is common and good practice with large steam turbines where gound space is of great value (as it usually is in power stations in large cities) to place the condenser in a basement below the exhaust end of the turbine. Of course, when ground space can be afforded on the engine room floor, it is better to place the condenser alongside the engine where it can more easily be got at. The condenser and pumps usually require much more attention than the turbine.

Although a reciprocating engine does not benefit to the same extent as a turbine by having a very good vacuum, there is nevertheless usually a very great economy to be effected by employing condensing plant. A good non-condensing reciprocating engine will usually, if provided with a condenser maintaining a vacuum of 25 inches of mercury, have its steam consumption per indicated horse power per hour reduced at least 20 per cent.; and many non-condensing engines now in use employing low-pressure steam could have a much greater reduction effected by the employment of condensing.

Besides the reduction in steam consumption brought about by condensation, we have in many cases to allow for a reduction in the coal consumed for a given amount of steam generated, owing to feed water being obtainable from the hot well at a higher temperature than feed water could be obtained if a non-condensing engine were used. On the other hand, the fact must be taken into account that the water in the hot well is usually greasy owing to the mixture with the the water of lubricating oil. This oil has to be removed from the feed water; otherwise the boiler heating surface soon becomes ineffective through getting a deposit of grease, and the boiler may even be rendered dangerous from this cause. Usually the oil is removed from the water by oil filters or separators. Sometimes the oil is sought to be removed from the exhaust steam before this enters the condenser, and sometimes both methods are employed at the same time. These oil separators are troublesome, and generally speaking are a long way from being entirely satisfactory. The steam turbine scores a decided advantage over the reciprocating engine in having no oil in its exhaust steam.

AN ANALYSIS OF CENTRAL-STATION OPERATING COSTS AND REVENUE.

By H. S. Knowlton.

IN the recently published Twentieth Annual Report of the Massachusetts Board of Gas and Electric-Light Commissioners, covering the year ending June 30, 1904, appears a vast amount of interesting data, in bulk, upon the business of artificial illumination as conducted in that State. Returns are included from twenty-six companies supplying both gas and electric light, and from sixty-eight furnishing electricity only. There are also included the reports of twenty-one municipal plants, four of which do a combined gas and electric-lighting business, the other seventeen devoting themselves to electrical supply alone. Interesting and important as these total figures deservedly are, there are many significant points which are suggestive only when exhibited on a unit basis.

The analysis of the income and expenses of all the central stations in the State shows that the gross earnings of the companies for the year ending June 30, 1904, amounted to $7,663,961.52. Over $3,125,000 of this was earned by the Edison Electric Illuminating Co. of Boston alone. In order to get a concrete idea of the distribution of the receipts and expenses in the central stations of the State as a whole, we may resort to a tabulation of these accounts on the basis of $1.00 as a unit, following the general method of analysis sometimes used in apportioning a street-railway five-cent fare.

Each dollar earned by the central stations of Massachusetts, then, for the year under consideration, was made as follows:—

INCOME.

From sale of commercial arc lights by contract	$ .029
" " " " incandescent lights by contract	.049
" " " " arc and incandescent lamps by meter.	.508
" " " public arc lights	.192
" " " " incandescent lights	.051
" " " electric power	.157
" " " current to other companies	.007
" rent " motors	.001
" " " fixtures	.001
" " " meters	.001
" steam heating	.004
Total	$1.000

These figures are much more significant to the engineer than the totals from which they were derived. It is at once evident that the bulk of central-station business—83 per cent., in fact—consists of commercial lighting on meter and contract rates. A striking feature is the small proportion represented by the earnings from the sale of power—less than 16 per cent. While this does not by any means indicate the relative volume of lighting and power-energy output, since the power rates are presumably lower than the lighting charges, it is evident that there is room for working up a much larger motor business. The tabulation of motor horse power connected, in the report itself, shows this, as there are but seven companies having 1,000 horse power or over in motors wired to their circuits. These are as follows:—

Edison Electric Illuminating Co., Boston	24,150	horse power.
Lowell Electric Light Corporation	3,504	" "
United Electric Light Co., Springfield	2,306	" "
Haverhill Electric Co.	1,720	" "
Cambridge Electric Light Co.	1,525	" "
Lynn Gas and Electric Co.	1,400	" "
Worcester Electric Light Co.	1,073	" "

The expenses of the central stations of Massachusetts, on the basis of payment from each dollar earned, were as follows:—

Expenses	
Coal and other fuel	$.145
Rent of real estate used for plant	.012
Oil and waste	.005
Water	.006
Wages at station	.073
Station repairs	.006
Steam-plant repairs	.015
Electric-plant repairs	.014
Apparatus and machinery	.006
Wages for care of lights and meters, clerical labor in this department, and salary or commission of collectors	.030
Repairs and renewals of lines, meters, lamps, and motors	.063
Distribution tools and appliances	.006
Carbons	.009
Incandescent lamps	.022
Globes	.001
Directors' allowances	.001
Salaries of officers	.024
General salaries	.032
Rent of offices, if separate from plant	.003
General office expenses	.022
Taxes	.068
Insurance	.014
Law expenses	.007
Claims	.001
Bad debts	.005
Incidental expenses	.001
Current bought	.009
Total	$.600

The peculiar distribution of the operating expenses among a large number of small items, relatively speaking, is at once evident from the foregoing tabulation. The comparatively small part played by salaries and wages in the total expense budget is noteworthy—a strong contrast to the condition obtaining in electric-railway circles. The largest single item of expense is the fuel account, followed at a considerable distance by wages at stations, taxes, and repairs and renewals of the distributing system. Singularly enough, the cost of renewing incandescent lamps equals the general office expenses.

Following out the partitioning of the dollar of gross income a little further in the report, we have:—interest $0.055; dividends, $0.201; and depreciation, $0.026. Presumably, interest is computed upon the total investment at the beginning of the year at the rate paid upon the bonds or notes, and depreciation at the rate of 5 per cent. upon the cost of the plant as shown by the books at the beginning of the year. In taxes, six companies paid at the rate of over $10,000 a year, ranging from the Boston Edison's $312,000 and slightly over to Lynn's $10,231.

Among the larger cities of the State, underground-conduit construction has been increasingly adopted, so that in this class, Worcester exceeds every other city of prominence in the ratio of underground to the total length of wire in service. Worcester has 46 per cent. of its wire mileage underground—a total of 392 miles. The Boston Edison follows with 41 per cent. and a total of 1,292 miles below the surface of the streets. Springfield, Lowell, Fall River, Brookline and New Bedford are likewise running up promising totals.

The gross earnings per ton of coal burned are interesting, in the different cities of prominence. To an extent at least, it is an index of the operating efficiency of the whole system, given fuel of the same heating power per ton. Taking those cities burning over 4,000 tons of coal per annum, and excluding those which use water power or burn any considerable amount of coke or screenings, we have:—

GROSS EARNINGS PER TON OF COAL BURNED.

Edison Electric Illuminating Co., Boston	$48.50
Worcester Electric Light Co	40.20
Cambridge Electric Light Co	26.60
Lowell Electric Light Corp	25.50
Fall River Electric Light Co	25.00
Waltham Gas Light Co	24.70
Edison Electric Illuminating Co., Brockton	22.80
Chelsea Gas Light Co	18.80
Hyde Park Electric Light Co	13.80
Pittsfield Electric Co	13.60

It must be borne in mind that the above comparisons are limited, since the quality of coal burned and other factors cannot be assumed to be identical in any two different places. At the same time the upper figures of the table are worth striving to attain. If a plant burns many tons of inferior coal, it cannot of course reach the figures of return in gross earnings per unit of fuel consumed which are so notable in the cases of Boston and Worcester.

Gross earnings per capita for a given installation are often interesting to the engineer who is called upon to estimate upon different electric-lighting propositions, as well as to the station manager, himself. In the following table these data for Massachusetts cities of 15,000 and over are given, together with a statement of the ratio of operating expenses to gross earnings and dividends paid:—

GROSS EARNINGS PER CAPITA, POPULATION, ETC. (15,000 OR OVER) ELECTRIC LIGHT COMPANIES.

Company.	Population Served.	Gross Earnings per Capita.	Operat'g Ratio.	Per Cent. Dividends
Edison (Boston)	630,000 (approx.)	$4.95	.52	10
Worcester E. L...........	118,421	2.46	.52	8
Lowell E. L..............	105,411	2.21	.61	8
Fall River E. L...........	104,863	1.98	.63	7
Cambridge E. L...........	95,815	2.35	.57	6
Malden E. L..............	89,206	2.15	.71	8
Lawrence G.	81,127	1.84	.65	..
Lynn G. and E...........	79,297	2.87	.68	..
United (Springfield)	69,975	4.35	.56	8
New Bedford G. and E....	66,009	1.85	.53	..
Newton and Watertown G.	43,293	2.24	.92	..
Charlestown G. and E....	40,652	1.37	.74	..
Edison (Brockton)	40,063	2.76	.57	5
Haverhill E.	39,551	2.20	.73	8
Brookline G. L............	39,214	4.98	.51	..
Salem E. L...............	35,956	3.40	.69	..
Chelsea G. L..............	34,072	2.55	.62	..
Fitchburg G. and E.......	31,531	2.38	.70	..
Gloucester E.	30,713	1.98	.69	7
Woburn L., H. and P.....	27,699	2.50	.86	..
Pittsfield E.	24,780	4.67	.86	8
No. Adams G............	24,200	3.63	.79	..
Quincy E. L. and P......	23,899	2.50	.60	5
Waltham G. L............	23,481	4.28	.69	..
Northampton E. L........	18,643	2.55	.58	8
Central Mass. (Palmer)...	17,068	2.70	.55	..
Suburban (Revere)	16,453	5.00	.60	..
Marlboro E.	15,530	1.92	.82	..

Probably the most noteworthy feature of these figures is the variation in them, in different cities. There would seem to be room for the increasing of central-station business in many of the cities tabulated, as well as decreasing the cost of operation. Although variable local conditions preclude the drawing of any very definite comparisons between the different cities, there is no gainsaying the fact that a high average of gross earnings per capita means that the company is at least endeavoring to extend its business to the saturation point of the community which it serves. Generally speaking, when the ratio of expenses to gross earnings continues to stand in the upper register, it is time to look around the power station for obsolete equipment and wasteful methods of operation.

It is manifestly impossible to draw from the foregoing tabulation any conclusions in regard to the relations existing between population and gross earnings per capita. The number of cities of each group of approximately equal population is too small for the determination of anything like a fair average. If the table does nothing else, it illustrates how widely conditions vary, even between the cities of a single commonwealth. Useful as it is to know what are the gross earnings per capita of an electric-light company in existing cities, it is apparent that the same figures cannot be applied to other cities of approximately equal size without knowing something of those cities along general economic lines. That electric lighting as a business is still in a transition stage is evident from a study of these data, and other figures in the report itself. The wide discrepancies between the different companies' showings prove beyond question that there is room for the practice of expert engineering in bringing a higher standard of efficiency to the front. In the light of modern scientific progress, there would seem to be no need of such tremendous differences in the cost of generating, distributing, and selling electricity for power and lighting in communities less than two-hundred miles apart.

In conclusion, nothing in the foregoing paragraphs is intended to belittle any quantity met in the central-station business as too small for attention on the part of the manager desiring to keep receipts up and expenses down. The analysis of the income and expenditures of the various companies on the basis of each dollar earned was made for the purpose of comparison—to enable the proportions and relations between the different items to be quickly realized. Thus, oil and waste amount to but half of one per cent. of the total cost of operation; but in toto the cost of these items amounted to nearly $4,000 during the year. Evidently, then, it is worth while for any central-station man to cut a quarter, or even a sixteenth, of a cent from his operating expenses in each of the dollars which make up the oil-and-waste account, and the same reasoning applies to practically every other detail of station and distribution service. If any manager or engineer finds food for thought in this all-too-brief anaylsis of a few of the striking features of central-station practice in Massachusetts, the object of the writer will be attained.

COST KEEPING ON GENERAL CONTRACT WORK.

By A. W. Buel.

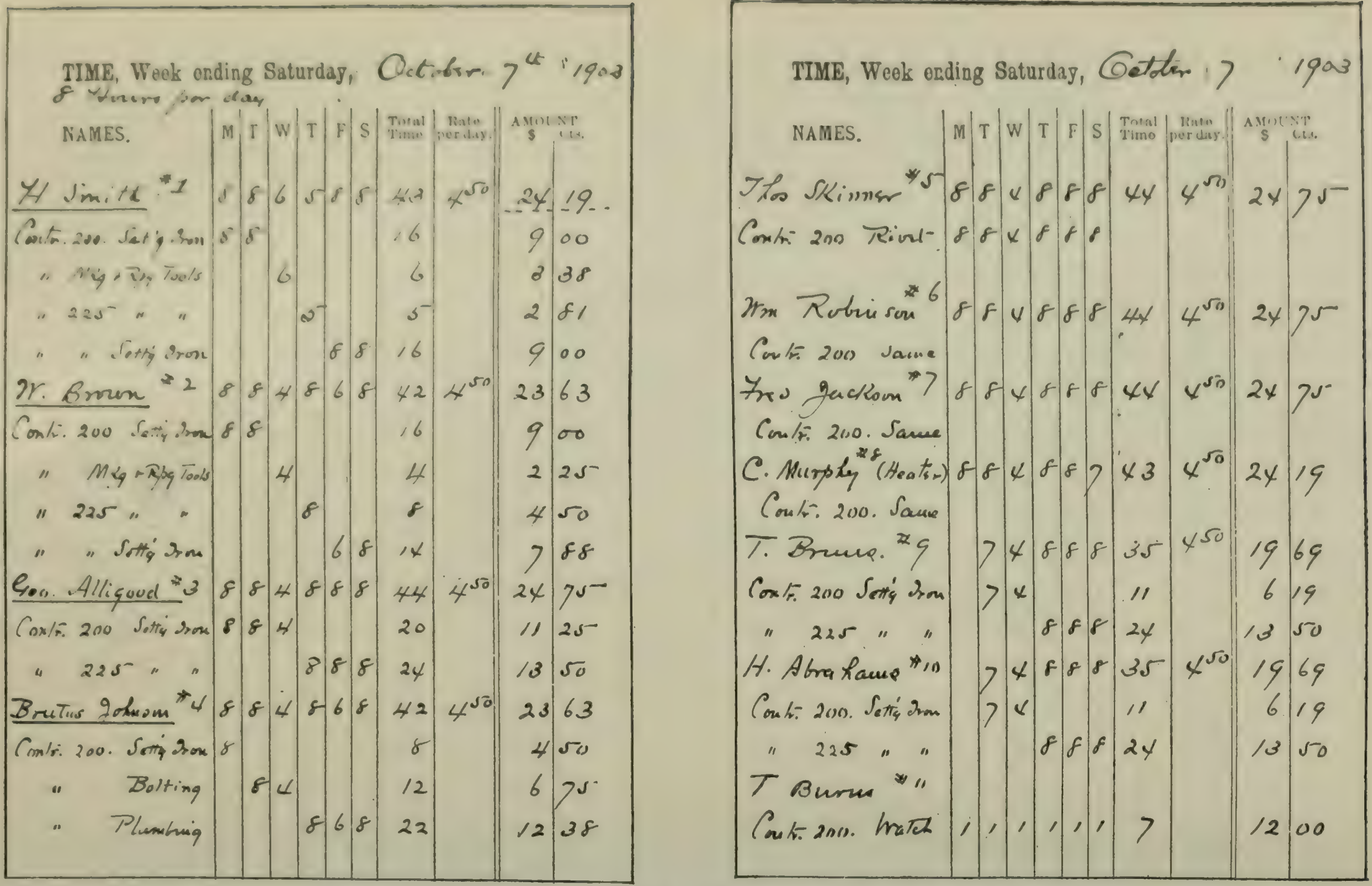
II. THE WORKING SYSTEMS OF SEVERAL SUCCESSFUL CONTRACTORS.

Mr. Buel's first paper (published in our April issue) pointed out the commercial value of prompt and accurate figures of costs. The one now presented describes several plans in actual use, for thus finding and recording costs. A following article will propose an extension of cost-keeping methods on contract work by the use of the best available modern facilities.—The Editors.

THIS outline of several systems of cost keeping, illustrating the practice of successful contractors, has not been attempted without some hesitation. A complete presentation, in greater detail, might be more satisfactory; but sufficient data have not been obtainable. It remains for those who have devised or are using modern methods to write up full descriptions. Anyone who expects to find a system already in use that he can copy exactly and transplant to his own business, under different conditions and personnel, is likely to be disappointed. After all, very simple and imperfect descriptions often give rise to important suggestions, and not infrequently in unforeseen directions. Such a result, in the present case, will be very satisfactory to the writer.

The Terry and Tench Company of New York are engaged almost exclusively in the erection of structural steel, in which line they have broken several records, both in time and cost. Erection records are not broken nowadays without good management and an efficient organization. Directness in all operations is also essential, and this feature is in evidence in their system of keeping labor accounts.

Form A shows two pages from their weekly time books. Each man's total time in hours is entered in the column for the day, opposite his name, and his total time for the week, the rate, and total amount earned are carried out in their respective columns. Under each name the distribution is entered on separate lines for each class of work and each contract, the totals of the time and amounts in the distribution balancing with the total time and amounts opposite the man's name. The amounts for each class of work and for each contract for the week, are then collected and added as shown on Form B. The totals of Form B are entered each week on Form C, and when



TIME, Week ending Saturday, October 7th 1903
8 Hours per day

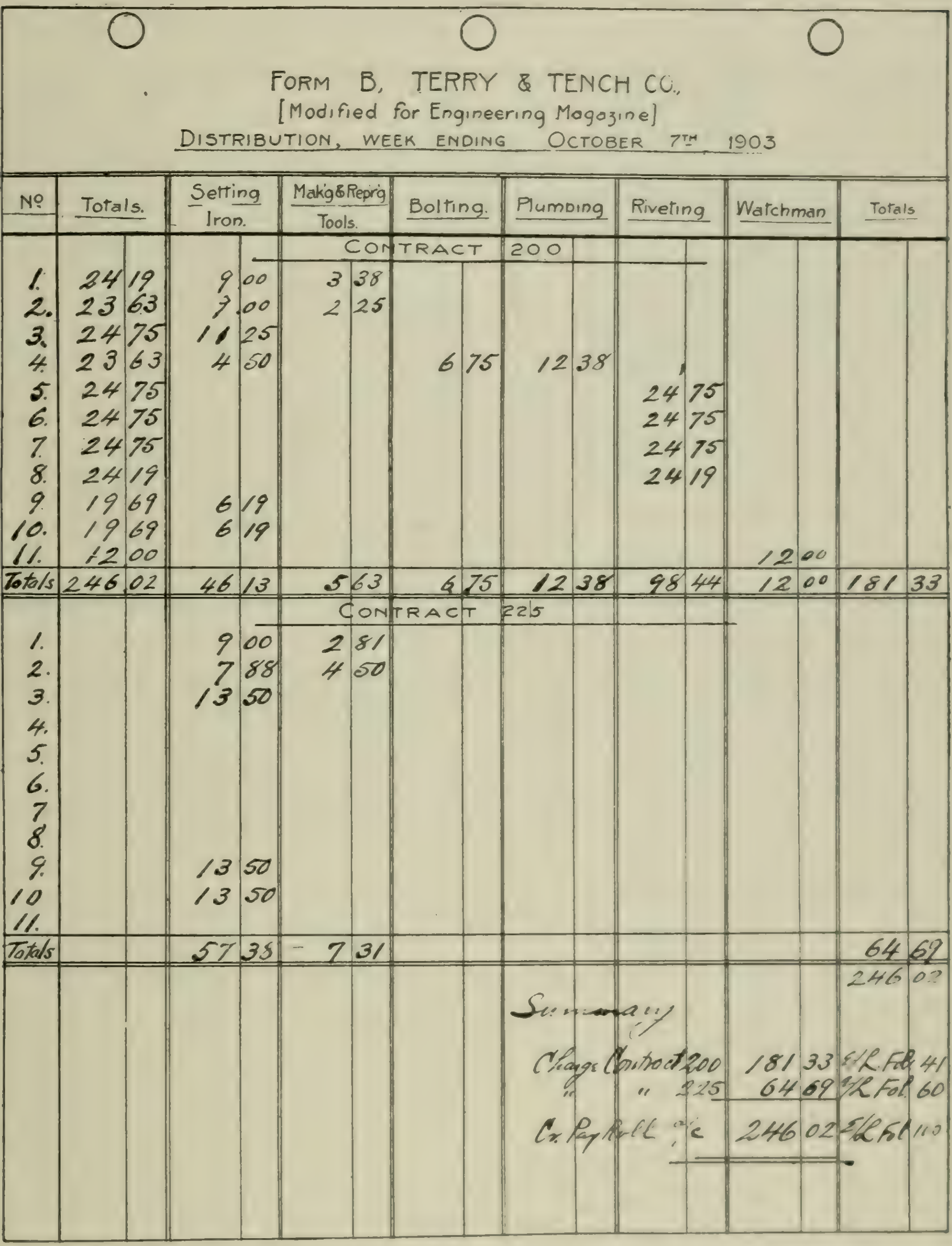
NAMES.	M	T	W	T	F	S	Total Time	Rate per day.	AMOUNT $	Cts.
H. Smith #1	8	8	6	5	8	8	43	4^{50}	24	19
Contr. 200. Set'g Iron	8	8					16		9	00
" Mfg & Rpg Tools			6				6		3	38
" 225 " "				5			5		2	81
" " Sett'g Iron					8	8	16		9	00
W. Brown #2	8	8	4	8	6	8	42	4^{50}	23	63
Contr. 200 Sett'g Iron	8	8					16		9	00
" Mfg & Rpg Tools			4				4		2	25
" 225 " "				8			8		4	50
" " Sett'g Iron					6	8	14		7	88
Geo. Alligood #3	8	8	4	8	8	8	44	4^{50}	24	75
Contr. 200 Sett'g Iron	8	8	4				20		11	25
" 225 " "				8	8	8	24		13	50
Brutus Johnson #4	8	8	4	8	6	8	42	4^{50}	23	63
Contr. 200. Sett'g Iron	8						8		4	50
" Bolting		8	4				12		6	75
" Plumbing				8	6	8	22		12	38

TIME, Week ending Saturday, October 7 1903

NAMES.	M	T	W	T	F	S	Total Time	Rate per day.	AMOUNT $	Cts.
Thos Skinner #5	8	8	4	8	8	8	44	4^{50}	24	75
Contr. 200 Rivet.	8	8	4	8	8	8				
Wm Robinson #6	8	8	4	8	8	8	44	4^{50}	24	75
Contr. 200 Same										
Fred Jackson #7	8	8	4	8	8	8	44	4^{50}	24	75
Contr. 200. Same										
C. Murphy #8 (Heater)	8	8	4	8	8	7	43	4^{50}	24	19
Contr. 200. Same										
T. Bruce. #9		7	4	8	8	8	35	4^{50}	19	69
Contr. 200 Sett'g Iron		7	4				11		6	19
" 225 " "				8	8	8	24		13	50
H. Abrahams #10		7	4	8	8	8	35	4^{50}	19	69
Contr. 200. Sett'g Iron		7	4				11		6	19
" 225 " "				8	8	8	24		13	50
T Burns #11										
Contr. 200. Watch	1	1	1	1	1	1	7		12	00

FORM A. TWO PAGES FROM DAILY TIME BOOK, TERRY & TENCH CO.

As entered here, the week is kept in the usual way from Monday to Saturday. In point of fact, the firm's time books have the day letters charged so as to keep a week from Thursday to Wednesday.



FORM B, TERRY & TENCH CO.
[Modified for Engineering Magazine]
DISTRIBUTION, WEEK ENDING OCTOBER 7TH 1903

Nº	Totals.	Setting Iron.	Mak'g & Rep'r'g Tools.	Bolting.	Plumbing	Riveting	Watchman	Totals
			CONTRACT 200					
1.	24 19	9 00	3 38					
2.	23 63	7 00	2 25					
3.	24 75	11 25						
4.	23 63	4 50		6 75	12 38			
5.	24 75					24 75		
6.	24 75					24 75		
7.	24 75					24 75		
8.	24 19					24 19		
9.	19 69	6 19						
10.	19 69	6 19						
11.	12 00						12 00	
Totals	246 02	46 13	5 63	6 75	12 38	98 44	12 00	181 33
			CONTRACT 225					
1.		9 00	2 81					
2.		7 88	4 50					
3.		13 50						
4.								
5.								
6.								
7								
8.								
9.		13 50						
10		13 50						
11.								
Totals		57 38	7 31					64 69
								246 02

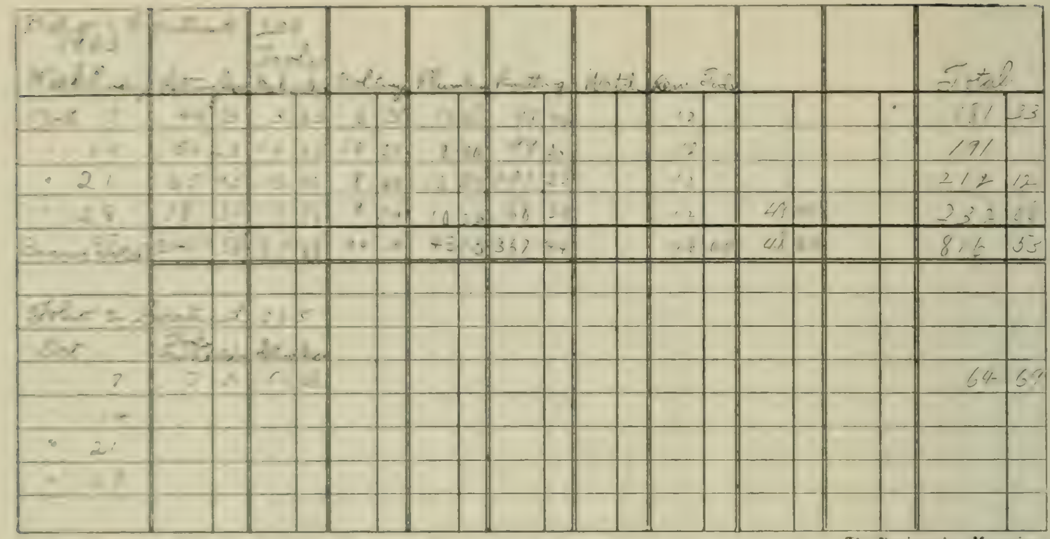
Summary

Charge Contract 200 181 33 E/L Fol. 41
" " 225 64 69 E/L Fol. 60
Cr. Pay Roll a/c 246 02 E/L Fol 110

FORM B. TERRY & TENCH CO. DISTRIBUTION OF WEEK'S WAGES.

a job is finished, the columns of this last form are added up, giving the total cost of labor on the contract and the total of each class.

With the record of the number of tons of iron set, riveted, etc., each week, which is not difficult to keep, the cost per ton for each part of the work can be obtained in a few minutes. All of this information is available on the day following the close of the weekly time roll, or Thursday of each week. Should it then appear, for



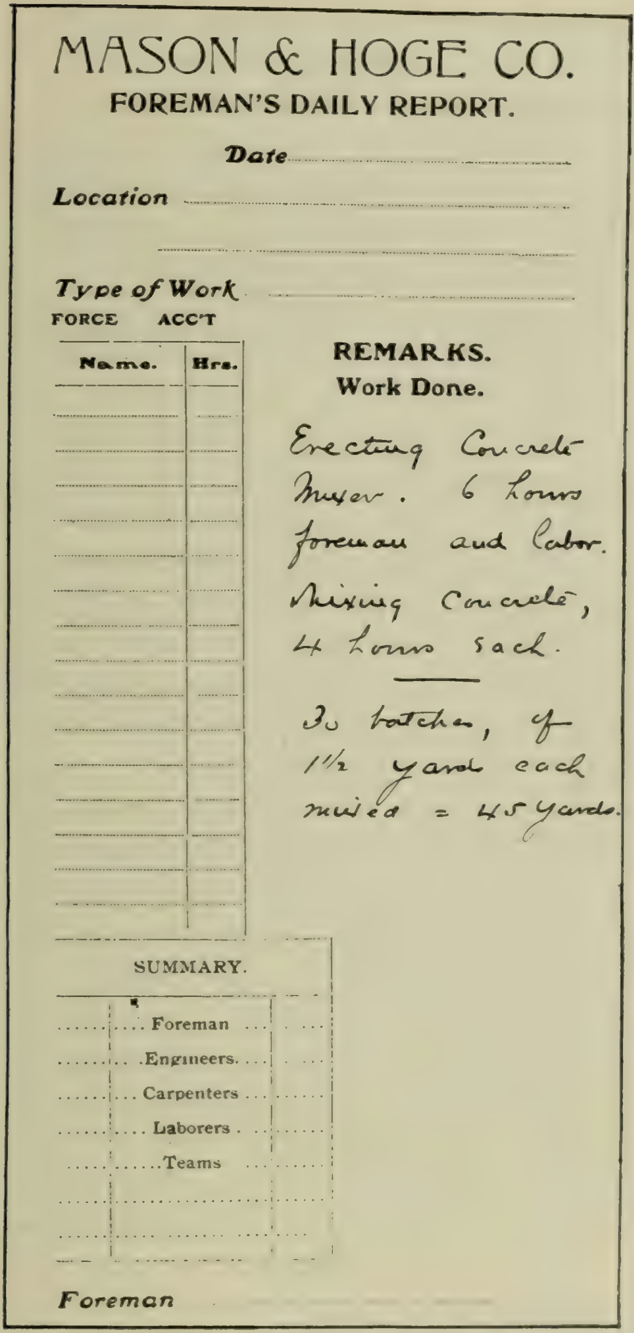
The Engineering Magazine

FORM C. TERRY & TENCH CO. TOTAL DISTRIBUTION OF LABOR ON A CONTRACT.

instance, that the riveting or setting of iron on a contract has cost more that the estimate, or more than it should have cost, the superintendent's attention is immediately directed to the fact, with the result that the efficiency of the labor is improved or a good and sufficient reason for the increased cost is recorded. Where several gangs, bosses, and foremen are working on the same or comparable work, this system will show which are the most efficient, and "natural selection" will take care of those who fall below established standards.

This system is simple and gives quick results in very satisfactory detail. Any competent time keeper can handle it, and without any additional expense. It is particularly adapted to a business where the number of accounts in the distribution is not large, and for a relatively small force. Where a large number of men, say over two hundred, are employed in one locality, the form of the time books could be changed to advantage. Other variations will no doubt occur to any one in adapting it to the requirements of his particular business.

The method employed by the Mason and Hoge Company (incorporated) and T. H. Riddle Construction Company, is applicable to large and diversified works. It is understood to have given satisfactory results on their contract for Lock and Dam No. 10, Kentucky River. The time keeper goes over the work twice a day and enters the time of the men in a time book, which has no special features requiring description. Each foreman also records the time of his men on daily report sheets (D), and gives the detailed classification and amount of work done in the space under "Remarks—Work Done." The location and type of work are given at the head of the sheet.



MASON & HOGE CO.

FOREMAN'S DAILY REPORT.

Date

Location

Type of Work

FORCE ACC'T

Name.	Hrs.

REMARKS.

Work Done.

Erecting Concrete Mixer. 6 hours foreman and labor. Mixing Concrete, 4 hours each.

30 batches, of 1½ yard each mixed = 45 yards.

SUMMARY.

Foreman

Engineers.

Carpenters

Laborers

Teams

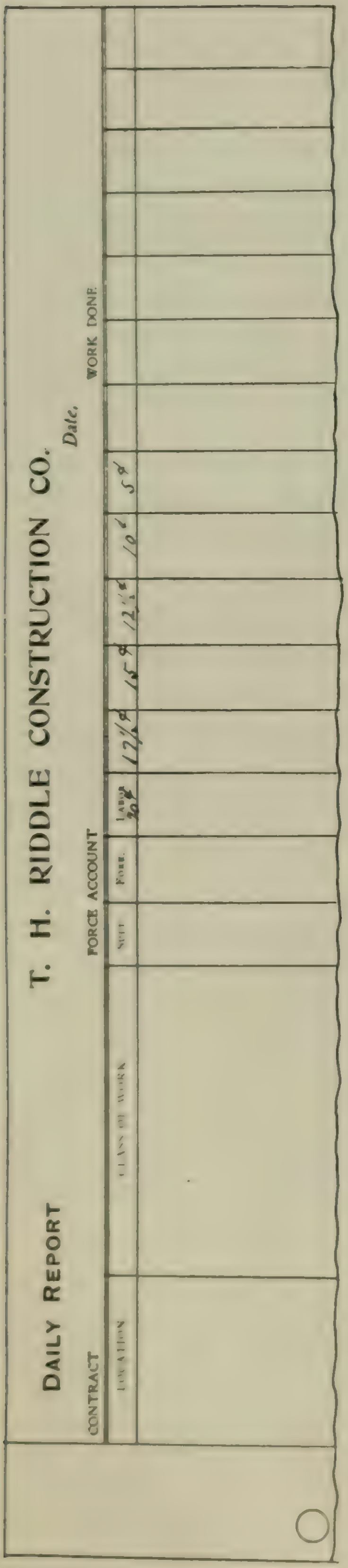
Foreman

FORM D. FOREMAN'S REPORT.

These report sheets are turned in to the time keeper at the end of each day, and he checks his time book with the foreman's reports and enters up the classification. This makes a good check on the time of the men, and has been found advantageous in cases of dispute on pay day. If the detailed classification could be given in tabulated form instead of in general notes in the space under Remarks, it would no doubt be clearer and more accurate. The average foreman is not likely to be over-concise and clear in written notes, and the time keeper is likely to have some trouble until he becomes familiar with them. All data of any importance, except such as are concerned with irregularities, should be, as far as possible, eliminated from the remarks column.

The basis of the system seems to be that the gang, foreman and men, reported on one sheet, Form D, constitute a working unit, and the classification and distribution of time is the same for all the names on the sheet. In many cases such a condition cannot be maintained, and no specific provision being made for correctly recording irregularities in the distribution of the time of members of the unit, the resulting distribution of costs can only be approximate, with an indeterminate error.

The summaries of all the foremen's reports for the day are then



T. H. RIDDLE CONSTRUCTION CO.

Date,

DAILY REPORT

CONTRACT

FORCE ACCOUNT

WORK DONE

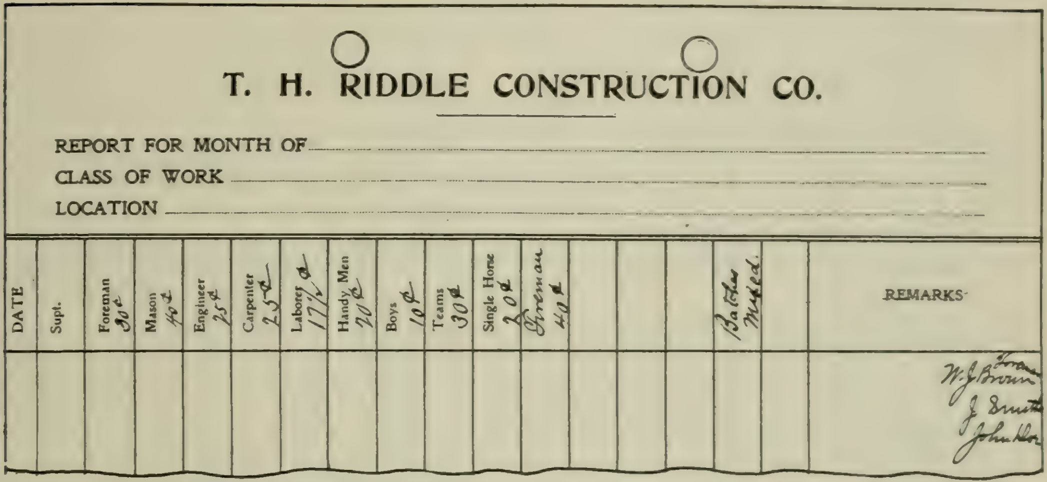
LOCATION	CLASS OF WORK	SUPT.	FORE.	LABOR 20¢	17½¢	15¢	12½¢	10¢	5¢							

FORM E. DAILY REPORT SHEET.

entered on a Daily Report Sheet, Form E, one line on the latter being used for each foreman. The amount of work done of each class is entered in the columns on the right-hand side of the sheet. When a foreman and his men have had only one class of work for the day, the unit cost of labor can be readily extended on this sheet. It is not clear how this can be easily or accurately done when more than one class of work is reported by the same foreman, unless a separate line is used for each class and each foreman's report, which would require no extra expenditure except for paper. In any case the degree of accuracy will remain that of the gang-working-unit system, which is an unknown and variable quantity.

The daily report sheets, Form E, are made out for the use of the superintendent, and if each morning he has on his desk the report for the previous day, with unit costs extended as indicated above, he should find it of great assistance in economical administration. Much time and labor in extending unit costs can be saved by the use of a slide rule, which gives results with an accuracy of a fraction of one per cent. These reports are transmitted to the main office and filed.

The Monthly Report Sheet, Form F, quoting from the explanation of the system furnished by Mr. Richard Lahey, "is made up from either sheets D or E, preferably from D, and a separate sheet is used for each sub-division of the work. Thus concreting may have eleven sheets viz., 1 quarrying; 2, hauling stone; 3, crushing stone; 4, haul-



T. H. RIDDLE CONSTRUCTION CO.

REPORT FOR MONTH OF

CLASS OF WORK

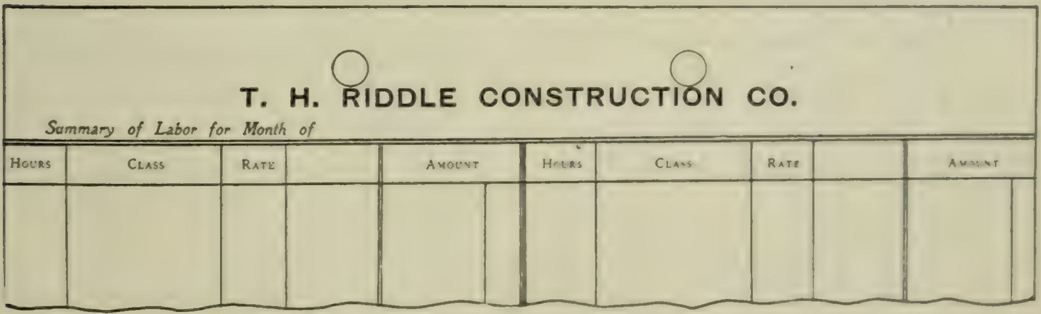
LOCATION

DATE	Supt.	Foreman 30¢	Mason 40¢	Engineer 25¢	Carpenter 25¢	Laborer ¢ 17½	Handy Men 20¢	Boys 10¢	Teams 30¢	Single Horse 20¢	Foreman 40¢				Batches Mixed		REMARKS
																	W. J. Brown Foreman J. Smith John Doe

FORM F. MONTHLY REPORT SHEET.

ing sand; 5, hauling cement; 6, mixing concrete; 7, hauling concrete; 8, placing concrete; 9, building forms; 10, erecting crusher; 11, repairs to crusher. The object is to get the cost of erection and repairs separately, and also, as far as possible, that of all the other items. On these sheets are entered the hours and rates and the work done. For convenience in reference, the name of the foreman making the report is entered in the Remarks column. The time of the office force is also tabulated and distributed. At the end of each month these sheets are footed, and the unit costs worked out."

The summary of all the monthy report sheets, F, for each month, is made out on sheet G, and this must balance with the monthly pay roll. Materials and supplies are required to be accompanied on delivery by an invoice, on which the articles are checked off as received and the distribution noted, as "charge to account of repairs to crusher," or "charge to account of concrete forms for * * * *," etc. These are then entered and distributed on their proper sheets.



T. H. RIDDLE CONSTRUCTION CO.

Summary of Labor for Month of

Hours	Class	Rate		Amount		Hours	Class	Rate		Amount	

FORM G. SUMMARY OF MONTHLY REPORTS.

Purchases for "account of plant" are charged to the work or subdivision on which they are first used, and when afterwards used on other work or on another sub-division, the first is given a credit. If

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COST OF WORK ON

Date 19[illegible]		Excavating		Shoring		Concrete		Rubble Stone		Common Brick		Face Brick		Enamel Brick	
		Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material
Estimate Aug.	20	2300	200	600	300	3000	9000	1600	4000	5000	7000	3400	6000	2500	8000
October	31	2000	175	580	250	1560	6800	800	2000	600	780				
Nov.	30					990	2000	700	2000	2400	3600	1800	3600	1600	4500

Marble Work		Mosaic		Ornamental Iron		Electric Wiring		Freight Expenses				
Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material	Total Labor	Total Material	Grand Total
4000	9000	2400	4000	2000	15000	2000	4000	600	2000	64100 00	161200 00	227900 00
								150	200	5540 00	15445 00	15895 00
								160	300	10990 00	30600 00	42050 00

FORM H. HEADINGS OF COST LEDGER FOR DISTRIBUTION OF ACCOUNTS.

The upper figure shows about one-half of the first page, the lower figure showing the right-hand half of the opposite page. The two pages together constitute a single "Folio" in the ledger. The columns omitted are:—Iron Work, Fireproofing, Mortar for Fireproofing Rough Grounds, Plastering, Roofing, Sheet Metal, Doors, Windows, Chair Rail, Picture Mould, Base, Glazing, Painting.

used on a third, the second receives a credit and perhaps the first receives a small additional credit. At the end of the job, credit is allowed to it for the value of plant and materials turned in.

Mr. Lahey writes:—" I have found that by using loose sheets and Shannon filing cases, the work is simplified, as the number of sheets required each month varies according to the work on hand."

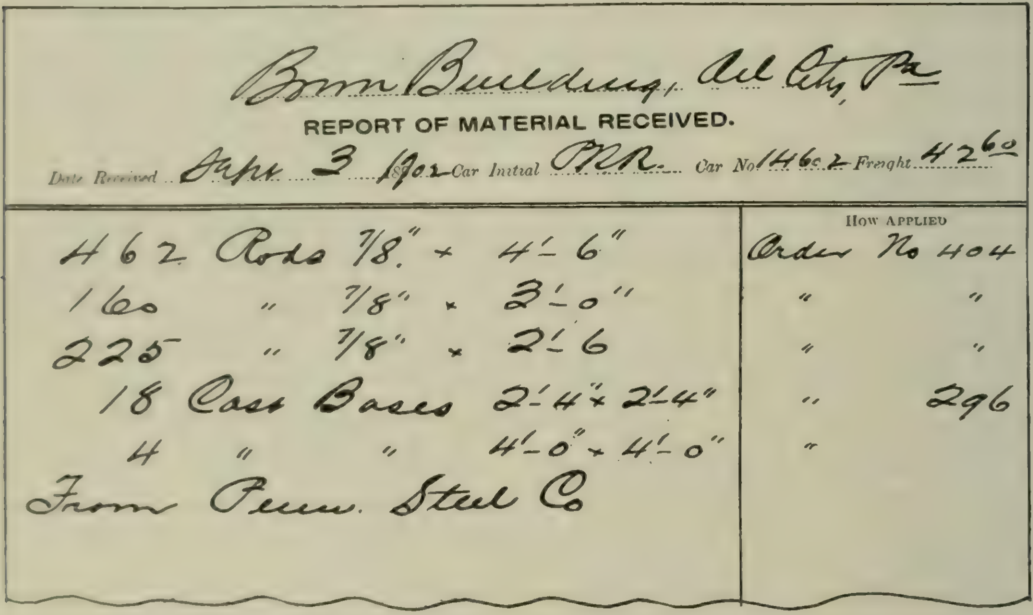
The sheets must balance with the regular office books, which consist of a time book, journal, and ledger.

In response to a request from the editors of THE ENGINEERING MAGAZINE, a firm of builders who operate on a large scale and over a wide territory have kindly furnished a description of their cost-keeping system, with samples of the forms employed. The latter are reproduced here as Forms H, J, K, and L. This firm writes:—" We do not desire any particular credit for anything of value to you, which you may find in the foregoing, but would rather that you treat the same anonymously." The following description is quoted verbatim from their letter:—

" Our books consist of the regular double-entry cash book, journal, and ledger, together with an independent cost ledger. An estimate of the cost of a particular contract is made on loose leaves of legal-cap size, which are then bound together, labeled, and filed away in a convenient place. If the contract is awarded us, we then open an account with the job, in the cost-ledger, a sample page of which we enclose herewith marked Form H. At the same time an account is also opened with a job on our general ledger, to which all charges and credits of every nature are made from day to day. At the end of each month these charges are transferred to the cost-ledger account, properly distributed and classified, and balanced with the general ledger. This is as often as we have found it necessary to balance our books. However, there is nothing to prevent a comparison at the end of each week, as we receive each day reports of all materials received on a job during that day, for the purpose of checking invoices, on a blank form enclosed herewith marked Form J, and at the end of each week, on pay day, a full financial report from the superintendent in charge, on blank enclosed, marked Form K. This blank, in addition to various miscellaneous disbursements for the week, is entered the total amount of the pay roll. From each workman on the building we take a receipt like sample enclosed herewith and marked Form L. On this receipt the man's time is entered each day by the time keeper on the building, and the time is classified by letter according to a key with which we supply each time keeper. For example:—"A" stands for excavating, " B " for mixing concrete, " C " for laying concrete, "D" for laying rubble, "E" for laying common brick, "F" for mixing mortar, and so on indefinitely. Each week, upon receipt of these reports from the superintendents, they are carefully audited, the pay receipts classified and recapitulated, and the whole entered on the general ledger, the superintendent's account being credited and the account with the job charged in one amount.

"This all applies to contracts at any distance from our main office. On contracts near at hand, all moneys are handled by our main office, and all charges of every nature are made on the general ledger from day to day, and the cost ledger written up and balanced at the end of the month as heretofore explained.

"A separate account is kept on the cost ledger with all such items as freights, traveling expenses, etc., which cannot be accurately classified as they originate during the progress of the work, and when the work is completed they are then properly distributed and the units of cost computed for each branch of the work, to compare with estimated units."



Born Building, Oil City, Pa

REPORT OF MATERIAL RECEIVED.

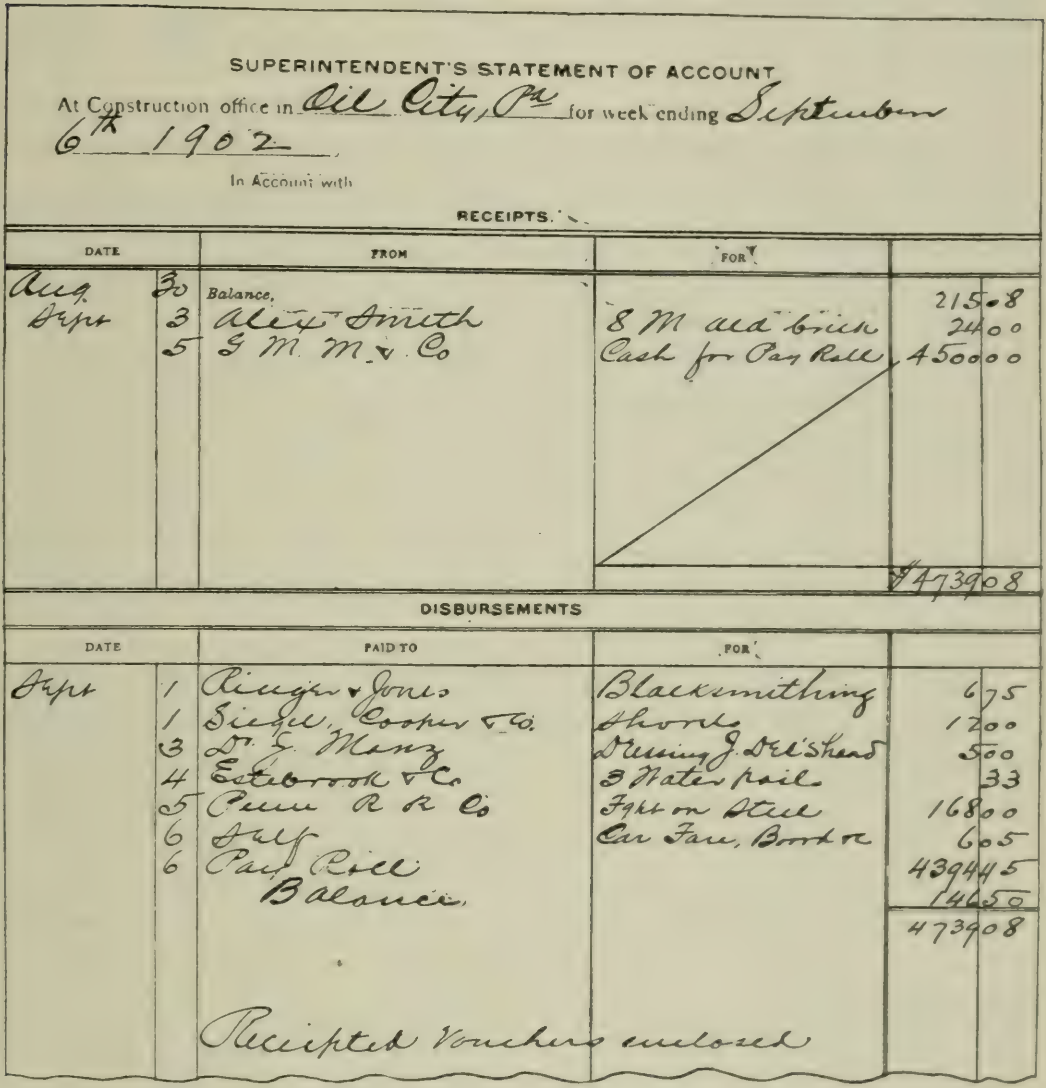
Date Received Sept 3 1902 Car Initial PRR Car No 14602 Freight 42^{60}

	HOW APPLIED
462 Rods 7/8" × 4'-6"	Order No 404
160 " 7/8" × 3'-0"	" "
225 " 7/8" × 2'-6	" "
18 Cast Bases 2'-4" × 2'-4"	" 296
4 " " 4'-0" × 4'-0"	"
From Penn. Steel Co	

FORM J. REPORT OF MATERIAL RECEIVED.

A separate report is made for each kind of material, whether brick, stone, sand, lime, cement, lumber, or stone—just what is on the car and from whom received. If deliveries are made by team, the number of thousand brick or yards of sand received that day are noted.

This system appears to contain elements worth some attention, and although it has been "evolved to meet particular requirements," it offers, with a few changes, considerable elasticity. It seems to be adapted to complex operations on a moderately large scale, but might prove unsatisfactory for very extensive works. About the most convenient paper for estimates is in sheets 8½ inches by 11 inches,



SUPERINTENDENT'S STATEMENT OF ACCOUNT

At Construction office in Oil City, Pa for week ending September 6th 1902.

In Account with

RECEIPTS.

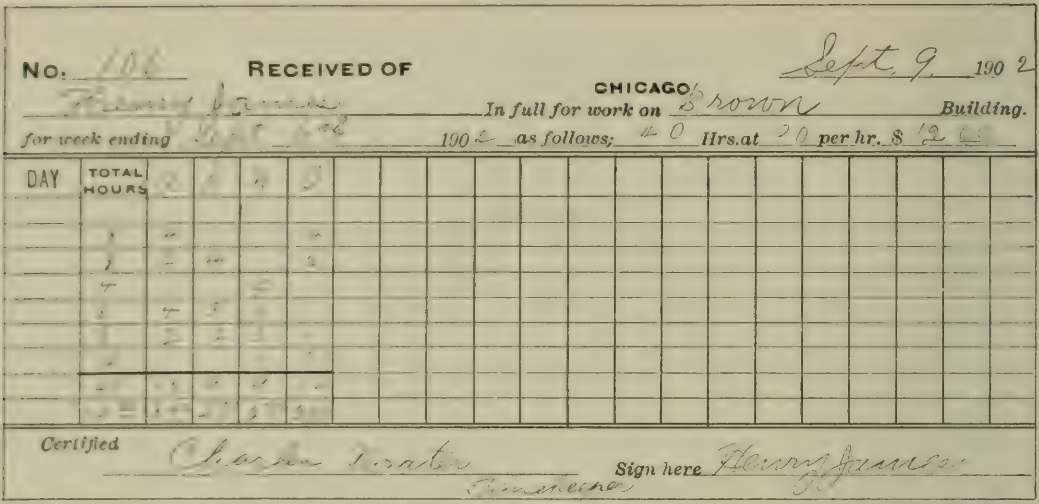
DATE		FROM	FOR		
Aug.	30	Balance,		215	08
Sept	3	Alex Smith	8 M old brick	24	00
	5	G M M & Co	Cash for Pay Roll	4500	00
				$4739	08

DISBURSEMENTS

DATE		PAID TO	FOR		
Sept	1	Ringer & Jones	Blacksmithing	6	75
	1	Siegel, Cooper & Co.	Shovels	12	00
	3	Dr. J. Manz	Dressing J. Dell's head	5	00
	4	Estabrook & Co	3 Water pails		33
	5	Penn R R Co	Fght on Steel	168	00
	6	Self	Car Fare, Board &c	6	05
	6	Pay Roll		4394	45
		Balance,		146	50
				4739	08
		Receipted Vouchers enclosed			

FORM K. SUPERINTENDENT'S STATEMENT OF ACCOUNT.
Original is about the size of legal cap. Signed at the foot by the superintendent.

with a double red line 1½ inches below the top, which is an 8½-inch side, and is punched for Unimatic or I. P. "loose-leaf" books. The books are, therefore, legal fold and made to order. Below the double red line the paper is quadrilled in blue, four to the inch, or thirty-four spaces wide and thirty-eight spaces between the double red line and the bottom of the sheet. Above the double red line are three parallel blue lines spaced ¼ inch apart. On the top line is written the title of the work, with the date on the right-hand side, and, in the three spaces below, sub-title, description, sheet number, etc. Sheets of this size can be conveniently filed with the original correspondence and data, or letters can easily be punched and inserted in the loose-leaf books. When the estimate is finished, the sheets and letters pertaining to it are removed from the book and bound together with a string, through the three holes at the top. They can then be indexed and filed away



No.   RECEIVED OF   CHICAGO, Sept. 9, 1902

In full for work on Brown Building.

for week ending 1902 as follows; 40 Hrs. at 20 per hr. $

DAY | TOTAL HOURS

Certified

Sign here Henry James

The Engineering Magazine

FORM L. WORKMAN'S WAGES RECEIPT. ORIGINAL IS 9 IN. WIDE BY 4 IN. HIGH.

by any system, but vertical files with numbered folders and a decimal system are the most convenient.

It is a good plan to have a standard form for estimates, and to take up each item in regular order. When there is nothing to estimate under an item, it is best to enter the item in its order and write after it "*none.*"

A good substitute for the special "cost ledger" may be made with an ordinary trial-balance book. The ruling is the same as that shown in Form H, and the size and shape of the book is in some respects more convenient. As many pages may be used for a contract as necessary to give two columns for each item, and by cutting off the two outer columns of the intermediate leaves required, the latter will fold back without covering up the date column on the first page.

In many cases it may be advisable to arrange the system so that the cost ledger can be posted from the original records, through distribution sheets, similar to Form B of the Terry and Tench Co., instead of from the general ledger. The amount of work of each kind done in each week or month can be reported and entered on the cost ledger above or below the cost, using two lines instead of one for each entry. The unit costs can then be read from a slide rule almost as rapidly as the results can be written, and may be interlined in red.

The suggestions given above are mostly derived from observation of other systems in use and are only intended to show how variations may be introduced in systems to make them available in other cases.

The writer and the editors of THE ENGINEERING MAGAZINE wish to make special acknowledgment to the contractors who lent their assistance in collecting and furnishing data for this article.

EDITORIAL COMMENT

THE reorganization of the Isthmian Canal Commission appears to promise remarkable success in securing the strength and the freedom of able individual management, while retaining the necessary legal form of a commission. The division of functions is eminently logical, and the character of the men placed at the executive head of the several departments assures energy and ability in the prosecution of the work henceforth. It is especially gratifying that Mr. Wallace, as chief engineer, has been advanced to a rank and dignity in the commission commensurate with the responsibility of his work and his personal and professional worth.

There seems to be some disposition to criticize the reported intention to make the consulting engineering committee international in its membership —criticism based nominally on the supposed difficulty which foreign members might find in apprehending American methods of work. The objection does not seem to be well supported, as the particular function suggested for the advisory board is to aid in the decision upon the type of canal, and not upon the mode of construction. This involves the solution of hydraulic problems, and deductions from experience in the operation of ship canals, in which the best authorities of the world may well be called in consultation. It is doubtless safe to assume that the proposed complexion of the board is thought desirable by the chief engineer, and he may well be depended upon to select the consulting engineers, as he may be entirely trusted afterwards to carry out the plans selected.

Two very interesting documents dealing with canal questions reach us too late for proper discussion in this issue. The first is the report of the chief engineer of the Isthmian Canal Commission for the period from June 1, 1904, to Feb. 1, 1905, giving an admirably clear summary of the work so far accomplished, and indicating unequivocally that the sea-level plan is Mr. Wallace's ultimate ideal. The second is a Project for the Panama Canal, by Mr. Lindon W. Bates, introduced by an impressive preface pointing out the world-wide importance of the undertaking, the duty resting upon the country and the engineering profession to avoid error in carrying it out, and his own conviction that "the announced methods of solution are not such as to secure . . . the best, the safest, and the most enduring canal." "Knowing further that there exists a more scientific method, it has become his duty, as well as his privilege, to set it forth." The project, which is quite new, controls the Chagres by dams at both Gamboa and Alhajuela, and establishes a summit level at about 20 feet above sea, creating two lakes ("Lake Chagres" and "Lake Panama") near the respective ends of the canal and giving a total of 17 miles of lake navigation. We hope to return to this interesting conception with a fuller notice next month.

* * *

A PLEASANT evidence of the growing recognition of "Production Engineering" as a distinct course in technical education comes to us this month in the form of a volume of Dr. Alex. C. Humphreys' "Lecture Notes on Some of the Business Features of Engineering Practice." They are published by Stevens Institute of Technology as part of the literature of the "Department of Business Engineering," and deal principally with accountancy as applied to the conduct and management of manufacturing and engineering concerns. This, of course, is an important element in the complete scheme of "Production Engineering"; more important still is the approach toward the conception of a specialized course of engineering training, adapted to teach the principles of the efficient and economical administration of industrial work.

* * *

The announcement of the award of the John Fritz gold medal to Lord Kelvin for his work in cable telegraphy, and for his other scientific achievements, shows that a fitting beginning has been made in the administration of this important charge by the representatives of the four national engineering societies. In all his career Lord Kelvin has shown such a close union between the work of the physicist and the engineer, as a man of both profound theory and of intensely practical application, that the award of the medal to him is a distinct indication of the intention of the founders to make the distinction one of the broadest and most comprehensive scope. With such a distinguished name at the head of the list the attainment of the John Fritz medal will acquire increased value to all succeeding holders, the record forming a roll of fame the admittance to which will constitute one of the highest rewards within the grasp of the profession.

* * *

In the first report to the steam-engine research committee of the Institution of Mechanical Engineers, reviewed at length elsewhere in this issue, Professor Capper brings out one point which demands more attention than it has hitherto received. The investigations showed that even with an experimental engine, specially prepared for scientific trials demanding the highest degree of accuracy, the leakage past the valves was sufficient to render the conclusions unreliable, had not the amount been measured to enable the correction to be made. Professor Capper even goes so far as to say that with *well-fitted* valves the leakage may amount to more than 20 per cent. of the steam entering the cylinder, and is rarely less than 4 per cent.

If such conditions are found under the surroundings of care and preparation accompanying scientific tests, what may be expected in the ordinary working of engines in mills and factories? Losses by internal condensation are not easy to determine, and can only be partially diminished; but it is evident that we have in many instances wastes nearly if not altogether as great by leakage as from condensation, and this from a cause much more controllable.

The leakage experiments made by Professor Capper were with slide valves only, and it would be of much value to have similar tests made with other forms. Incidentally, it may be a matter of interest to conjecture the extent to which steam-engine trials, hitherto regarded as trustworthy, may have been entirely vitiated by leakage effects, and the re-checking of results and conclusions in some important departments of steam engineering may be in order.

* * *

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REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

STEAM-ENGINE RESEARCH.

FIRST REPORT OF THE STEAM-ENGINE RESEARCH COMMITTEE UPON THE RESULTS OF PROGRESSIVE SPEED AND PRESSURE TRIALS.

Prof. D. S. Capper—Institution of Mechanical Engineers.

THE investigations conducted by the Institution of Mechanical Engineers form most valuable contributions to the various departments of work to which they relate, and the first report of the steam-engine research committee maintains the high standard set for it by its predecessors. The present report, prepared by Professor David S. Capper, incorporates the results of experiments made at King's College, London, covering trials with jacketed and unjacketed cylinders and trials at progressive pressures and speeds. These experiments were originally suggested by the late Mr. Bryan Donkin to investigate the subject of initial condensation in steam-engine cylinders. The plan suggested by Mr. Donkin involved the construction of a special steam engine, with three valves,—first, one to admit steam during lead; secondly, one to open at the commencement of the stroke and to act as an admission valve; and thirdly, an exhaust valve. By supplying the first and second valves from separate boilers, Mr. Donkin hoped that the steam required to replace initial condensation might be separately measured. Unfortunately this interesting investigation could not be undertaken, owing to difficulties in connection with the engine, and the researches of which the present paper is a report were made upon an engine of more ordinary design.

The engine, which is described in detail in the report, is a horizontal, cross-compound engine, but in the tests thus far made, only the high-pressure side was used. The cut-off was effected by a Meyer valve gear, adjustable by hand, and the cylinder could be operated by either high-pressure or condensing, and with or without jacket All the steam passing through the engine was delivered to a surface condenser, the discharge from which was carefully weighed at regular intervals, the engine being indicated and the load controlled on the fly-wheel by a rope brake.

The method of conducting the trials was as follows:

"Observers were placed at the boiler gauge, the engine gauges, the separator and calorimeter, at the indicator, at the brake, at the condenser, and at the condensed-water tank, so that observations of the readings of all the instruments could be taken at frequent intervals. Steam was raised in the boiler to the required pressure, and the engine having been started and run for some time until it was running steadily under the required conditions and steam pressure, the trial was commenced and observations were taken every five minutes for half an hour. If the conditions varied during the run to any considerable extent the trial was continued until a steady run of twenty minutes to half an hour was obtained. If the trial then seemed generally satisfactory, the conditions were altered and a further trial was run."

From more than one hundred trials there have been selected 38 as most closely satisfying the conditions laid down. The results of these are very fully tabulated in the report, while reproductions of indicator cards and copies of the heat diagrams are also given.

In order to correct the results of the trials from any errors due to the leakage of steam past the slide valves directly to the exhaust, without passing through the cylinder, a series of tests were made to determine the tightness of the valves. These tests were made by blocking the steam ports, driving the engine at the various speeds by external power, and admitting steam at the various pressures to the steam chest. By connecting the exhaust to a condensing coil all the leakage into the exhaust was measured and the results accurately determined. The results of these tests are very fully detailed in the report, and a leakage ranging from 36 to 56 pounds of steam per hour was found when the engine was standing, and an average of 45 pounds per hour when running at 50 revolutions.

The condensation of the steam, as well as the re-evaporation, together with the rate of interchange of heat between the steam and the cylinder walls, are all fully tabulated in the report, and a résumé of the results is interesting.

Thus, the total condensation up to cut-off increased with increased pressure and temperature of admission. As the cut-off was constant, condensation therefore increases with the difference between the temperature of admission and exhaust. This difference of temperature is sensibly the same for the jacketed and unjacketed series, yet the condensation increases with increase of temperature in a much higher ratio on the jacketed than on the unjacketed trials. The conclusion drawn from the experiments, so far as initial condensation is concerned, is that the losses due to condensation on the cylinder walls of unjacketed engines diminish with increased initial pressure and temperature for a given ratio of expansion quite independently of the rate of speed. It appears that if only the initial temperature could be sufficiently raised, jacketed and unjacketed engines would be equally efficient as regards initial condensation.

The total condensation decreases with increase of speed for the unjacketed series of trials, while with the jacketed series the same decrease appeared on the high temperature tests, and the opposite was shown on the low-temperature trials, the total condensation in the latter cases increasing with the speed.

So far as the rate of interchange of heat between the steam and the cylinder walls is concerned, this rate is about twice as high in the unjacketed trials as in the jacketed trials; this corresponding to the greater depth to which the cyclical temperature variation penetrates when the mean temperature of the cylinder walls is lowered by the absence of the jacket.

The tests showed that the jacket has little if any influence upon evaporation during expansion, and under the conditions under which these trials were carried out the regenerative action of the walls appeared to be quite as high without jackets as with them.

Professor Capper concludes the report with some general conclusions drawn from the whole series of experiments.

"It is dangerous to draw conclusions of too general and sweeping a character from experiments upon one type of engine under one set of conditions, but it may fairly be claimed that the ground covered by this report has never previously been surveyed with an engine showing more consistent and definite results, nor under conditions which enabled so detailed an analysis of the results to be made. It may therefore be anticipated with some confidence that the definite indications shown by the results form a real contribution to the present knowledge of the phenomena accompanying condensation and re-evaporation in an engine cylinder under given conditions of jacketing. The points which have been elucidated may be summarised as follows:—

"Firstly, leakage through the slide-valve, to the importance of which Messrs. Callendar and Nicolson have drawn attention, has been quantitatively determined under defined conditions, and has been shown to be nearly independent of speed of sliding surface and proportional to difference of pressure between the two sides of the valve. Further, it has been shown that the assumption that the leakage is inversely as the overlap of the valve is at least in the main well founded. And further that with well fitted valves the leakage may amount to over 20 per cent. of the steam entering the cylinder and is rarely less than 4 per cent.

"Secondly, it has been shown that for an unjacketed engine with a given ratio of expansion, initial condensation, expressed as a percentage of the steam in the cylinder, *diminishes* with increase of initial temperature, while the total condensation per stroke *increases* with such temperature increase.

"This, though suggested by Messrs. Callendar and Nicolson's researches, has never previously been demonstrated with clearness, as if leakage is not allowed for, the results are obscured and even reversed, and the conclusions arrived at without leakage allowance are therefore unreliable.

"Thirdly, it appears from the results here obtained that the re-evaporation for a given ratio of expansion is as great and sometimes greater without jackets than with them. This shows very clearly that the regenerative action of the cylinder walls with a given ratio of expansion is largely independent of their mean temperature.

"No quantitative analysis of re-evaporation is possible where leakage is not taken into account, as without the necessary allowance results would be largely illusory.

"Fourthly, it is possible from the results obtained to show the temperature when for any speed of revolution with a given rate of expansion the jackets will become unnecessary or wasteful."

The whole report is an example of careful and accurate research, and a continuance of such investigations should produce a series fully comparable with the masterly reports of the alloys research committee of the same Institution.

BLAST-FURNACE POWER-GAS IN AMERICA.

THE COMMERCIAL POSSIBILITIES OF BLAST-FURNACE GAS FOR THE DEVELOPMENT OF ELECTRIC POWER.

F. du P. Thomson—Electrochemical and Metallurgical Industry.

WE have repeatedly reviewed in these columns papers relating to the development of power by the use of waste gases from blast furnaces as fuel for internal-combustion motors, but in all cases these have referred to installations on the Continent, in Belgium, in Luxembourg, and in Germany. We now have a valuable paper by Mr. F. du P. Thomson, in a recent issue of *Electrochemical and Metallurgical Industry,* discussing the large gas-power plant of the Lackawanna Iron & Steel Company, at Buffalo, this paper being based upon the author's own practical experience with the only large installation of the kind in the United States.

Two things are essential to the success of a blast-furnace gas-power plant. There must be an available market for the surplus power over and above that required for the blowing engines of the works, and there must be an uninterrupted and fairly uniform supply of gas.

"To secure, within a reasonable degree of certainty, a continuity of supply, no group of less than three blast furnaces can be considered as available to supply a power plant, which is intended to produce power for the general market. At any group of furnaces at least one will at some time be out of blast for relining, and at least one other furnace may be stopped for some one other reason. With a group of three blast furnaces, therefore, the surplus gas of one will always be available.

"The value of a large number of units to obtain a given output of iron is very evident, if the development of a large percentage of the surplus gas into power is to be made possible. Increased cost of construction and operation of a blast furnace plant made up of a number of small units as compared with the same items of expense for a plant of the same capacity made up of large units, must be more than balanced by the profits which are to be realized from the operation of the larger power plant. Further than this, the prices obtained for the power must warrant the continuance in blast of all but one furnace of a blast furnace plant, when trade conditions would imperatively dictate a suspension of operation. The profit must at least pay the interest on the labor and material invested in manufacturing periods in which there is no market for the product and at least part of the loss due to a falling market.

"The blast furnace gas power plant is burdened with the responsibility of maintaining operations in spite of trouble which may occur at ore, stone and coal mines, coke ovens, along the lines of transportation, and finally at the blast furnace plant itself."

The general distribution of power derived from the furnace gases is shown by Mr. Thomson by a general analysis of the total amount of contained energy into the various proportions required for use in the production of iron, and the surplus available for the production of electricity for outside supply.

"The waste gases of the blast furnace contain about one-half of the total heat originally possessed by the fuel, and this is approximately in direct proportion to the coke consumption per ton of iron. It has been variously estimated that from 18 to 33 per cent. of this heat is required to heat the blast. A conservative estimate of the percentage of the heat of the waste gases to heat the blast would be 30 per cent., and one which would not, in general practice, be exceeded. For the compression of the blast by steam engines, giving an economy of 20 lb. of steam per horse-power per hour when run condensing, under normal conditions, with boilers which convert 60 per cent. to 70 per cent. of the heat of the gas burnt into heat of steam, requires from 33 per cent. to 40 per cent. of the heat of the waste gases. For auxiliary purposes, such as pumps, light power for hoists and ore-handling machinery, approximately 7 per cent. to 10 per cent. is required. By the substitution of gas blowing engines and gas engines for the production of power for auxiliaries, the figures above may be reduced to read 16.5 per cent. to 20 per cent. and 3.5 per cent. to 5 per cent.

"The wide difference between the surplus available under the head of steam engines, 42 to 17 per cent., is due principally to differences in efficiency of apparatus and only in a limited degree to differences in practice. The difference in surplus available under the head of gas engines, 52 to 42 per cent., depends almost entirely on differences in furnace practice, for the efficiency of the gas engine equipment is in each case the same. The maximum surplus with steam equipment is, curious to say, identical with the minimum to be expected with gas engine equipment.

"The superiority of the gas engine over the steam engine may appear rather small. It must be remembered, however, that the gas blowing engine operates normally at only about two-thirds of the load which it must be designed to carry when the blast pressure reaches 25 lb. to the square inch. Such periods of high pressure may be coincident with a poor quality of gas, making the conditions even worse than indicated above. The gas engine in such service is at a disadvantage compared with a steam engine designed to operate with economy at normal load, with capacity, however, to supply air at the highest pressures met with in general practice.

"Large gas engines are built to-day, which will, at full load, give a duty of 194,000,000 effective foot pounds, as compared with a duty of 82,000,000 effective foot pounds, from one of the best steam engines per 1,000,000 B.T.U. in the gas consumed in each case. As the economy of the gas blowing engine will approximate only 80 per cent. of the figure given above, it may readily be seen that its ultimate economy, in blowing engine practice, may be safely said not to exceed twice that of the steam engine."

Mr. Thomson discusses at length the methods and appliances employed for cooling the gas and freeing it from dust. The most effective gas washer has been found to be a fan, at the centre of which a jet of water is delivered, the fan breaking up the water into spray and mixing it with the dust, and at the same time delivering the mixture of water and dust out of the current of the gas by centrifugal force.

The commercial side of the question is dealt with by Mr. Thomson by considering two different classes. In the first class (A) provision is made for possible momentary overloads of 50 per cent., this requiring a gas engine of 2,000 horse power coupled to a 1,000 kw. generator. In the second class (B) the full load of the generator is taken as 80 per cent. of the engine capacity, and the generator load never exceeds 25 per cent., this being represented by a 2,000 horse power gas engine coupled to a generator of 1,500 kw.

In either class the space occupied would practically be the same, and require for each unit a length of 50 feet in a building 75 feet wide, together with some additional length to house the compressors, pumps, and exciters which go to complete the installation. No proposition except one which utilizes all the surplus gas need be considered. The following estimates are based upon the utilization of the surplus gas from a group of three or four 300-ton furnaces, in which the surplus gas from one furnace only may be utilized.

Taking the first class as consisting of four 1,000 kw. units, and the second as four 1,500 kw. units, the total costs are tabulated in detail, the totals being $580,000 and $600,000 respectively; corresponding to $145 per kilowatt for the first class and $100 per kilowatt for the second. The operative costs are tabulated in a similar manner, and work out at $90.24 per kilowatt year in the first case and $38.40 for the second; while assuming a profit of 10 per cent. the selling prices should be $128.70 and $55.15 per kilowatt-year respectively.

In general an increase in profits of about 30 cents per ton may be realized by the utilization of the waste gases, and since this is true from a plant which can convert but 25 per cent. of the surplus gas available, still better results may be expected from those at which the percentage of surplus convertible, owing to a greater number of furnaces, is greater. It should not be impossible to realize 75 cents, or more, per ton, where eight to ten furnaces are grouped.

" Wherever there is a large demand for power, and cheap water-power is not available and blast furnaces are, the blast-furnace gas engine power plant need fear no rival. We are not far from the day when the power house will be as much a part of every modern blast furnace plant as are the condenser and ammonia houses of the modern by-product coke plant."

THE SURFACE FINISHING OF METALS.

A REVIEW OF SCIENTIFIC METHODS OF STUDYING THE PHYSICAL STRUCTURE OF METALS BY AN EXAMINATION OF POLISHED SURFACES.

F. Osmond and G. Cartaud—Revue Générale des Sciences.

DURING the past few years the study of the physical structure of metals used in engineering work has become very general. It is well understood that the methods of metallography should not be permitted to displace those of chemical analysis, while the records of the testing machine must always be employed by the conscientious engineer, but in many cases the microscopical examination of polished and etched surfaces will explain peculiarities of behaviour, and reveal the consequences of manufacturing processes in a manner otherwise impossible.

Apart from the care which is necessary in the examination of the physical constitution of a metal under the microscope, an important element in the attainment of reliable results is found in the preparation of the surface of the material under consideration. For this reason the paper of MM. Osmond and Cartaud, in a recent number of the *Revue Générale des Sciences*, is of especial value, especially as it includes the experience gained by the former engineer of the Creusot Works, as well as that of an eminent French chemical engineer.

Leaving aside the details of etching and examining the metallic surfaces, the authors devote themselves especially to the preparation of the surfaces themselves, considering the methods of polishing as otherwise preparing the selected space for examination, and showing how this preparation may affect the results obtained.

Although the polishing of metals is one of the oldest of the arts it is one which has been almost entirely neglected in technical literature. Those investigators in the science of metallography who have made the most valuable contributions to our knowledge of the physical structure of metals have in nearly every instance been compelled to develop with their own labor the methods necessary to produce surfaces suitable for examination, while it may be shown that when the surface is not properly prepared the conclusions drawn may be altogether misleading.

When the surface of a metal is reduced,

either by a file or by such a medium as an emery paper, every tooth of the file and every grain of emery produces a scratch, the surface thus produced consisting of a mass of such scratches. Apart from the removal of the material effected by such means, the production of a scratch or similar break in the surface of a metal produces a very appreciable influence upon the material immediately surrounding, and as such methods form a portion of the operation of polishing preliminary to metallographical examination, these effects demand attention. Thus, when a depression is made in the surface of a metal by the point of a punch, or by a steel ball, as in the Brinell test for hardness, there will be produced what may be termed a series of undulatory waves in the mass of the material, and if the depression be produced far enough the deformation may develop lines of rupture within the material. In like manner the production of grooves or scratches by any tool, such as a file, will cause the development of internal stresses, so that the skin of the metal, as it may be termed, is in a different molecular condition from the interior of the mass. The extent of the effect of a scratch depends to a large extent upon the brittleness of the material. Thus the scratch of a diamond upon a piece of glass will affect the material so that it may be easily broken along the line of the break in the skin, while a scratch upon a material like gelatine or rubber may cause a more distinct break in the surface with a much shallower effect within the material. By examining scratched surfaces under the microscope the effect of the breaks in the surface upon the surrounding material may be studied, and the influence of the methods of preparing the surface is clearly visible.

The usual method of polishing a surface for metallographical examination includes the removal of a portion of the metal by some smoothing tool, such as a file, followed by a polishing by emery papers or cloth, of successive finenesses, the final specular polishing being effected by the use of some almost impalpable powder, such as rouge, tripoli, or as is now more generally employed, either alumina or chromic oxide, levigated according to the Schloesing proccess. By the use of such polishing materials a surface of a high degree of brilliancy may be obtained, and this, after having been subjected to the corrosive action of some etching medium, can be studied under the microscope.

However complete the polishing may appear, the operation really differs in degree only from the earlier stages in the preparation of the surface. The gradual increase in the fineness of the abrading material acts simply to produce finer and finer scratches, until the visible marks have been replaced by invisible ones. It has been assumed that this operation removes the surface film, which, according to Beilby, differs in physical constitution from the metal beneath, and that a new strained surface film is not produced, but this does not necessarily follow. In many instances the highest and most brilliant polish acts simply as a mask to conceal the artificial skin from the eye, while the application of either chemical or mechanical revealers will demonstrate the fact that the altered surface layer is still there. These facts are clearly shown by reproductions of a number of micro-photographs of etched surfaces, in which the action of etching solutions has brought out the lines and markings made by the operations of polishing the metal, and which to the untrained observer might give wholly erroneous ideas concerning the structure of the metal.

Another interesting method of revealing the existence of skin defects in a metal is the production of a new set of mechanical deformations. Thus, if deformation lines, sometimes called Lüders lines, such as are caused by punching or otherwise straining the material, be entirely polished out, so far as the eye can see, and the metal be subjected to a new method of deformation, such as pulling in a testing machine, the lines of the first deformation will re-appear upon the polished surface, showing that the molecular deformations had been masked only, and not removed. A similar action may be produced under the microscope, and a surface, apparently fully polished, will reveal surface lines if the skin be broken, as by the scratch of a diamond, if the specimen be subjected to pressure.

All these experiences go to show that the methods of preparation of a specimen for examination under the microscope act to create conditions of surface strain, amounting in some instances to an actual flow of the metal to an appreciable depth, and causing the polished surface to be very far from representing the true physical condition of the interior of the mass. It is altogether possible to avoid these deceptive conditions, at least to such an extent as to reduce the surface film to such a slight depth as to permit it to be readily penetrated by the etching solution, and this means that the greatest care should be taken, not only in the final polishing, but in the preliminary reduction of the surface, and in all the details of preparation. The service which the science of metallography has rendered in extending our knowledge of the physical constitution of metals is very great, but it should always be remembered that it must be used with judgment and with such a degree of care and skill in all details as to permit the conclusions to be accepted with the same freedom from self-deception as exists in other methods of investigation.

INTERNAL WATERWAYS IN GREAT BRITAIN.

AN EXAMINATION OF THE TRANSPORT POSSIBILITIES OF BRITISH INLAND NAVIGABLE WATERWAYS.

B. H. Thwaite—Society of Engineers.

NOTWITHSTANDING the development of improved systems of transport, both by steam and electric traction, there exists a tendency to advocate a return to water transport as a method which, while slow, must always remain one of the most economical systems for conveying bulky merchandise. In France the canal system has never been allowed to fall into decay and disuse, and in Germany there has been for a number of years past a determined effort to create a great system of internal waterways, composed of canals and canalised rivers. In England, on the contrary, the former extensive canal system has been permitted to deteriorate and fall largely into disuse, until at the present time it is at a condition of very low efficiency. In a valuable paper presented by Mr. B. H. Thwaite before a recent meeting of the Society of Engineers the possibilities of the internal waterways of Great Britain are discussed, and it is shown how the canal system may be restored to a high state of efficiency and made an important factor in rebuilding the agricultural prosperity of the country.

Mr. Thwaite reviews at some length the original development of the canals of England, and shows how closely they were connected with the prosperity of the nation down to the period when railways came into use. During the railway inflation period, after 1830, culminating in the boom of the forties, canal promotion enterprise was entirely overshadowed.

"The neglect of the canal system, as the result of the railway boom and government indifference to the fate of the canals, followed by the depreciation of the canal stocks, permitted the railway companies to initiate a policy of absorption as a preliminary to the destruction or suppression of their traffic competitor as far as practicable. For instance, the great railways purchased such lengths of canals as constituted competition against themselves, and which at the same time formed important links in the British navigable waterway system. This action destroyed the canal ensemble, and gave the railways the power of determining through canal rates. Thus whilst in the forties the agricultural interests were being attacked by the effect of the fiscal policy of free imports, the canal transit facilities of that industry were being undermined by the action of the railway administrators, in purchasing wherever desirable canal and other inland navigation rights at a price that was a bagatelle, compared with their intrinsic value. The government of the time could not have realised the effect of their indifference to the canal interests on the national well-being otherwise it would surely have been impossible for any railway board to have overridden the provisions of the Canal Acts."

"To-day we have a practical example of the policy of *laissez faire*, in the British railway system, which charges rates for railway transport in excess of the rates of our most dangerous industrial and commercial rivals. Our statesmen of the forties appear to have forgotten the axiom that the provision of the most efficient and economic transport arrangements is an all important step towards securing industrial and commercial prosperity. Subsequent governments realised their mistaken policy, but the passing of the Act of 1888 relating to canals was only an illustration of the policy of locking the stable door after the horse had been stolen. That Act forbids railway companies, in the absence of special and statutory authority to take over the control of canals. It also authorises canal companies to make arrangements with each other for through tolls, rates and traffic. Despite this Act the railway companies still hold their grip on the canals, although since the passing of the Act railway companies have shown a tendency to relinquish their canal properties, the Great Western Railway and the Midland Railway Companies having given up their control over important canals. However, British statesmen are becoming rapidly converted, and the passing of the Manchester Ship Canal Act in 1885 was a red letter day in the history of our canals."

Mr. Thwaite examines the advantages of transport by canal for certain kinds of merchandise in a very clear manner, showing how very cheap it is, and how it can be made still cheaper.

"A casual analysis of the broad distinctions that separate a canal system from a railway system demonstrates the *primâ facie* advantages of the canal system for the carriage of cattle, agricultural products, and the raw materials required for our factories, or generally for the carriage of heavy freights at slow speeds, or in which time is not the essential qualification of the transport system. For example, the capital cost of a canal is a mere fraction of that of a railway. The cost of a 50-ton capacity canal boat is far less than the cost of railway trucks of equivalent capacity. Moreover, the durability of canal boats is measured in terms of years and is very much greater than that of railway trucks, and it must obviously be so when the comparison of the nature of the traffic is considered, the almost destructive violence and smashing and clashing features of railways is absent from canal operations.

"Certainly, a reliable water supply source is necessary to satisfy lock and evaporation losses, but there is none of the expensive rail-wear associated with rail permanent way. The cost of making English canals is fairly represented by the figures of £3500 per mile. Against this the cost of railways per mile of formation looks seriously formidable if represented by the figure of £46,000 per mile. The capital amount actually paid up per mile of English and Welsh canals is said to equal £8472. The capital invested in British railways is said to be equal to £52,370 per mile."

The actual relation between the cost of freight transport by rail in various countries, as compared with canals, is tabulated as follows, showing the ton-miles to be had for the cost of a penny under the various systems:

British, rail	Ton-miles for a penny	1.25
French, "	" " "	1.66
German, "	" " "	2.00
America, "	" " "	4.00
Canal, horse haulage	" " "	13.00
Canal, electric haulage	" " "	24.66

This brings out the real contention advocated by Mr. Thwaite, the development of canals by the application of electric traction. Various methods have been proposed for this purpose, and any system, to be successful, must be applicable to existing canals without requiring extensive alterations. The so-called electric horse, a simple form of motor hauling device, offers the greatest advantages, and experiments in Germany and elsewhere have shown the entire practicability of the method. The plan proposed by Mr. Thwaite provides for the carrying of the traction motor on a single rail, supported on posts erected on the former tow path, a second higher rail on the same posts carrying a similar motor for traction in the opposite direction, this enabling boats to pass each other without entanglement of tow lines.

The important question in connection with electric traction on canals is the cost of the electrical energy, and this Mr. Thwaite proposes to meet by the utilisation of the energy in the waste gases of blast furnaces. By the employment of furnace gases in large gas engines the necessary electric power could be obtained from fuel now going to waste, while the application of this power to canal traction would create a revival in internal transport and consequently in industries dependent thereon.

"The following is an estimate of the cost of nationalising, perfecting, and electrifying our canal system. Assuming that 3500 miles of the canal system of Great Britain were purchasable at two-thirds of their original cost of construction, say £2350 per mile of length, then the capital required would be £8,225,000. Allowing £500 per mile for the cost of standardising the locks, and £2000 per mile for the electrification of the canals, then the total amount required would be £16,975,000. Allowing the balance to make up 20 millions to be set aside for working capital, it should secure for the State a splendid transport property. Seeing that over 60 millions sterling have been expended in tramway systems in this country, and that over 300 millions sterling have been absorbed in municipal work, the Government could surely be permitted by the country to become, like France and Germany, the owners of an efficient, electrified, navigable, inland water service.

"The proposed electrification of our canal system would, moreover, provide a cheap supply of electric power for export service, as well as for pumping, irrigation, ploughing, churning, milling, and vegetable and flower growth. The revivification of our inland navigable waterway system would go far towards securing a revival of our agricultural prosperity."

THE ELECTRIC DRIVING OF MACHINE TOOLS.

A REVIEW OF THE ADVANTAGES OF APPLYING INDEPENDENT ELECTRIC MOTORS FOR DRIVING MACHINE TOOLS.

George T. Hanchett—Electrical World and Engineer.

IT is evident that there is now little or no uncertainty as to the advantages of electricity for the transmission of power to tools in the machine shop. The troubles and inconveniences of shafting and belting, and the uncertainty of the losses involved by their use have long caused managers and engineers to hope for something better, and no one would now think of planning a new shop with any other medium than electricity for driving the machinery. At the same time there are several questions to be discussed in connection with electric driving, and it is beginning to be realized that the mere question of the amount of power to be saved is but a minor element among several which go to make up the arrangement of an electric power distribution system in a shop. In a paper in a recent issue of the *Electrical World and Engineer* these questions are discussed in a very clear manner by Mr. George T. Hanchett, from whose article we make some abstracts.

"The advantages of driving tools directly by motors are the following:

"1. Saving in time. 2. Increased output of the tool. 3. Convenience in shop arrangement. 4. Saving in power.

"These items are placed in their order of importance. The first three items pertain to saving in time, the last to saving in power. Modern machine shop practice has shown that machinist's time at $3 per day is a more important item than electricity at 10 cents per kw-hour, and the comparison of these items is so marked that in the writer's opinion it is good practice to carry motor-driven machine tool driving to a far greater extent than has commonly been considered good practice. The motor-driven machine tool permits of being placed in any position without regard to counter-shafting, and therefore in the best position with reference to light. An item of even greater importance is that each man's tool may be placed in close proximity to his bench, so that it is but a step from one to another. Much time is lost in walking about a shop and in carrying heavy work from a machine to the bench, or vice versa.

"The absence of counter-shafting also enables an elaborate trolley system of I beams to be suspended over the tools so that heavy work can be moved from place to place and swung into the lathe or planer with great facility. It is, furthermore, possible to group tools in such a way that progressive processes will be possible; that is to say, the piece of work can pass from shaper to lathe and to drill press in such an order that the least time is consumed.

"The convenience of manipulation now being apparent, it is well to spend a few moments' consideration upon the expedition with which the work can be performed once it is in the tool. It is a notable fact that machine tools almost without exception are under-belted; that is to say, the belt width is not capable of driving the tool with all the force that the machine itself will stand. Some tools, indeed, are more favorably belted than others, but the exigencies of installing a belted outfit often requires that the belt be unfavorably short or with the tight side in the wrong position or at an improper angle—very often directly vertical, in which position a belt has minimum power. With the direct application of a motor to a tool, which should always be by some positive drive, such as a chain or gear in order to eliminate the belt difficulties just mentioned, the motor may be proportioned so as to develop all the force that the tool will endure, and therefore much saving in time is gained by taking the heaviest possible cuts. Furthermore, the proper application of motors to tools has unquestionably developed the fact that work of large diameter can be handled in machines that were totally inadequate for the purpose before, the range of the machine being thus enhanced.

"Speed of cutting is another item to which little attention has been paid in the past in the average machine shop. The machinist steps his belt until it has a speed which appears to him "about right," and then finishes the entire job at that speed. If a lathe, the speed may be right on the large diameter and altogether too slow for the small diameter, but the time consumed in stopping the lathe and changing the belt is an item which usually constitutes an inconvenience so great that it is neglected. With the motor-driven tool the machinist can start the small diameter cut at high speed and as the tool feeds outward the controller can be stepped down, and this, combined with the possibilities of heavier cuts, very frequently reduces the time 50 per cent.

Mr. Hanchett very properly places the saving of power by the installation of electric driving as the last element to be considered. As a matter of fact the consumption of power forms a comparatively unimportant element in shop cost, and the extent to which electricity aids in the saving of labor and time far outweighs any power economy which may be effected. As a matter of fact there is a fair saving of power, although this is not so great as was at first supposed might be the case. In a well arranged shop it has been shown that the power consumed by the shafting and belting under the old arrangement was about 40 per cent. of the total; while with electric driving the proportion of power required for the transmission and subdivision may fairly be taken at about 30 per cent. of the whole. With electric driving there is the further advantage that a greater proportion is saved when tools are not in use, and as about one-half the tools are out of active operation during the day the efficiency of the motor driven shop may be taken at about 80 per cent. as against 60 per cent. for the shafting and belt driving system.

"In finally deciding the matter, a great deal of practical sense is necessary. The various advantages of machine tool drive—and it may here be properly reiterated that saving in power is one of the least of these—should be carefully considered and equated against the added investment, which it is safe to assume is 200 per cent. greater than with belts and counter-shafts, from an investment standpoint. From a maintenance standpoint, however, it will usually be found that a properly designed motor-driven installation will show a saving over the belt-driven proposition; for the attention that belts and counter-shafts require, the wearing out of belts, their breakage and the loss of time thereby entailed is greater than will obtain with the motor-driven proposition.

"It is practically an impossibility to say in a general way where individual drive should cease and where group driving should begin. Every shop presents a different problem. It is usually safe to drive groups of like tools which are being constantly used, such as in brass departments where many small parts are being drilled and tapped continuously by cheap help, partly for the reason that there is no necessity for great power at the tools, partly because individual drives would result in undue expense due to the large number of small motors, partly because the saving in power is microscopic, due to the fact that the department is running continually, and partly because shop arrangement is not of paramount importance, and the help in such a department usually stay constantly by the tool and pass the work from the box on one side of the tool to a box on the other and do practically no bench work. On the other hand, very large tools and groups of tools which are operated by expensive machinists who alternate from tool to tool and from tool to bench, can almost always be profitably driven by direct drive. In any of these cases, however, special advantages due to the situation may arise which will materially alter matters; therefore, each case must be treated by itself."

Mr. Hanchett takes up the subject of methods of variable speed control, showing that this may be practically accomplished in any one of three methods, viz., by varying the armature voltage; by varying the strength of the field; and by varying the number of effective conductors on the armature. Of these the method of feed control appears to be best adapted for motors driving machine tools, while excellent results have also been obtained by the employment of a balancer in connection with control by armature voltage. Combinations of the several control systems have also been used to advantage, and this is a matter which should be decided for every case according to the requirements, after a study of the character of the tools and the nature of the work.

SPEED LIMITS OF GAS ENGINES.

CONSTRUCTIVE AND OPERATIVE LIMITS TO INCREASE IN ROTATIVE SPEED FOR INTERNAL-COMBUSTION MOTORS.

Herbert L. Towle—American Machinist.

IT has well been said that it is exceedingly unsafe to predict the limitations to the development of any branch of art or science, and the impossible of one generation sometimes becomes the daily experience of its successor. When, however, the conditions of the problem are clearly stated and understood it is both possible and desirable to determine the limitations which surround their observance. In a paper in a recent issue of the *American Machinist,* Mr. Herbert L. Towle discusses the ultimate limit of speed in gas engines, and viewed in the light of the conditions set forth, his deductions are interesting and valuable.

In the first place, Mr. Towle discusses only the small, high-speed internal-combustion motors such as are extensively used for driving automobiles and motor boats. Such machines have at present no standard speed, either rotative or in piston feet per minute, the practice of different makers varying materially. The original idea of Daimler, when he undertook to re-design the heavy stationary gas engine into a small, light, and yet powerful motor for vehicles, was to improve the mechanism so that the speed might be greatly increased, and thus permit the power to be increased and the weight diminished. In his day the ignition appeared to be the limiting element, and hence he replaced the old Otto slide by the hot-tube ignition, and this has since been superseded by the electric spark, and at the present time the normal piston speed of these little engines, if such a thing as a normal speed may be admitted, is about 900 feet per minute, which, when accelerated for racing, reaches 1,200, 1,400, or even 1,500 feet per minute for hours at a time.

In considering the whole subject, Mr.. Towle puts the following questions:

"First, what is the highest speed, in an engineering sense, possible; and, when this highest speed has been determined, with what degree of closeness can the normal running speeds of commercial motors be brought up to it?"

The practical obstacles suggested by builders to high motor speed may be summarized as follows: 1, Vibration; 2, Wear of piston, rings, and bearings; 3, Sluggish flame propagation and decreased torque; 4, Overheating; and to these general wear and tear may be added. At the same time none of these is sufficient, from an engineering point of view, to fix definitely the ultimate limit of speed.

"Vibration has already been amply demonstrated to be negligible in vertical motors of four or more cylinders, and, for moderate powers, not of serious moment even with three cylinders, except perhaps at certain critical speeds, when the vibration period of the motor happens to synchronize with that of the springs on which it is mounted, or the hull in which it is placed.

"Ordinary wear is simply a question of bearing surfaces, proper materials, and efficient lubrication. The last is indeed a difficult problem, and many builders, especially of the older type of launch motors, do not know how to lubricate effectively such parts as the crank and wrist pins. Still, the most efficient lubrication possible is by no means so common as it some day will be, at least where small engines are concerned. As to the piston and its rings, there is no way to save them from wear, but we may be very sure that if there were no other objections to high speed the purchaser would cheerfully pay the cost of new rings and an occasional new set of pistons, and of the necessary reboring of the cylinders, for the sake of getting, say, 15 or 20 horse-power, instead of 10, from a given size of engine.

"Rapid flame propagation may be secured by an intense spark, and, if necessary, by igniting at two or more points within the cylinder. Even in the fastest automobile motors multiple ignition is hardly considered necessary to-day, and there is no immediate prospect of our being compelled to exhaust the possibilities in this direction. It is indeed necessary to use high compression, and a very good carburetter, if high piston speeds are aimed at, but each year sees carburetters improved, and high compression is no longer the bugbear of designers that it used to be. Compressions of 90 or 100 pounds per square inch are now used successfully in many automobile engines.

"Overheating of the piston and of parts projecting into the combustion space is undoubtedly a frequent factor in restricting speed. Its influence, however, is rather indirect, since its effect is to necessitate a moderate compression, with which high speed is hardly possible. It might be imagined that this factor would be a serious one, but it has not been found so, at least with cylinders up to 8 inches in bore, and it seems probable that piston diameters of 9 or 10 inches can successfully be used with high compression in gasoline engines, before recourse must be had to water injection or other devices to prevent premature ignition."

The question of getting the fresh charge into the cylinder and the exhaust out of it, is a problem requiring mechanical ingenuity, but by the employment of multiple valves of sufficient size, this matter can be provided for.

The real limit to rotative speed, in the present state of the art, is the same as exists in other reciprocating engines, that is, the inertia effects of the reciprocating parts. Thus, the inertia force of the piston, wrist-pin, and connecting rod, acts as a drag on the crank pin at the beginning of the stroke, while at the end of the stroke it tends to hasten it. If, at the upper or outer end of the stroke this force exceeds the compression pressure in the cylinder, there will be trouble. This will be clear when it is considered that unless the compression exceeds the opposing force to a sufficient degree to hold the parts in contact, the connecting rod will be lifted until the slack of the crank-pin bearing is taken up, and when the explosion comes it will drive the rod down on the pin again, producing a destructive knock.

Mr. Towle gives the well-known formulas for computing the inertia effects for various weights and speeds, and also constructs diagrams enabling the question to be solved graphically. Applying the computation to an engine of 6-inch bore by 7-inch stroke, with reciprocating parts weighing 13 pounds, it is shown that the running speed of 1,000 revolutions per minute is just about the practical maximum for this machine, and that any higher speed would cause destructive knock. A similar calculation for a 4 by 5-inch engine in which the reciprocating parts weigh 6 pounds, shows that with a speed of 1,200 revolutions the inertia force and compression are nearly equal at 50 degrees.

"As this speed is frequently exceeded in automobile motors, the reason for the abnormally light design of the pistons and rods of engines of the De Dion type is at once manifest. The factor of safety in these parts is hardly large enough to be worth considering, but it is only the paucity of this factor that makes such speeds practicable on any terms. These motors have at least shown that by using a piston length only equal to the diameter with semi-steel for material, and the very thinnest and most accurate of castings, as piston for a bore of 100 millimeters can be made to weigh only a trifle over 2 pounds, and the connecting rod and wrist pin will weigh less than as much again. We may therefore say that for ordinary launch engines the limit of speed is from 1,200 revolutions per minute for small engines down to about 800 revolutions per minute for the largest."

Having determined the practical maximum rotative speeds for existing designs of small internal-combustion engines, Mr. Towle maintains that there is no good reason why these speeds should not be at once made the normal speeds for continuous running. By applying the system of forced lubrication, already accepted in high-speed steam engines, turbines, and other machinery, no trouble need be experienced with bearings, and the knowledge that the maximum limit is not really exceeded enables the machines to be operated with a full sense of safety.

Of course the entire discussion of Mr. Towle relates to reciprocating engines, but if the reciprocating parts are altogether dispensed with, the limitations consequent upon their use disappear with them. If the gas turbine can be made an accomplished fact, as it may be before very long in the form of the mixed gas and steam turbine, there is no reason why it should not find immediate application to automobile vehicles as well as to motor boats. The problem then will be not to attain a sufficiently high speed for the engine but rather to find an acceptable means of reducing it. Probably frictional driving gear, with all the advantages of graduated speed control, will enter into practical service, since the high linear speeds involved would mean correspondingly low surface contact pressures, and thus the speed limit would probably be transferred from the control of inertia forces to the meeting of direct centrifugal stresses, and the problem simply takes another form.

THE COST OF ELECTRIC POWER.

A DISCUSSION OF THE INFLUENCE OF THE LOAD FACTOR ON THE COST OF PRODUCING ELECTRIC POWER.

E. M. Archibald—Canadian Society of Civil Engineers.

THE manufacture of electrical energy for sale to outside customers has brought out a number of problems which demanded little or no attention in the earlier practice of power generation for general manufacturing and mill purposes. The well regulated factory runs along for a certain number of hours every day, and the load, while it may show a gradual tendency to increase until the engine and boiler find themselves staggering along under all they can bear, does not show any very great fluctuations in the course of the working day. There are exceptions to this rule, and some may remember the small machine shop in which all the other machinery was thrown off towards afternoon twice a week in order that the foundry blower might be run up to speed. With the introduction of electric lighting and the gradual development of the central power station, however, it has been realized that there are certain well defined oscillations in the demand for electrical energy for correspondingly distinct purposes, and the question of the equalization of the load factor has become an important matter to the central station engineer. In a paper recently presented before the Canadian Society of Civil Engineers by Mr. E. M. Archibald, the influence of the load factor upon the cost of power is discussed, and some extracts will be found of general interest.

"The great desideratum for an electrical system is a high load-factor with consequent greatest return on investment; load-factor being the ratio of average to maximum load. All the factors of expense included in cost of power to the consumer are then operating at maximum economy, and cost of power is at a minimum.

The lighting of residences and offices produces a peak in the late afternoon and evening, with but little load the remainder of the twenty-four hours; consequently the average load on the plant with lighting only is very small and the load-factor low. A commercial motor load in connection with lighting will increase the average load even though causing a greater peak. The addition of a street railway load still further increases the day load, but in consequence of the heavy demand load during the rush hours, when the public is going to and from business, which occurs at the peak load on the plant is greatly increased. This heavy peak, with but a small average load over the twenty-four hours, produces a low load-factor, and a portion of the machinery being shut down the greater part of the time, higher rates must be paid by the consumer to secure a certain return on first investment than when the load-factor is higher.

"Evidently, when the load-factor is 100 per cent., that is, when the load is constant throughout the twenty-four hours, and all the machinery is in continuous operation, the cost of power per kilowatt-hour is a minimum, and the greatest return on investment is realized. Customers having a steady load or with high average load are greatly desired and may be offered better rates than all others. It will be the endeavor of this paper to determine the decreased cost of power with increasing load-factor.

"The storage battery is evidently a means in the hands of the power producing company of increasing the average load on the machinery. By charging the battery during light load and discharging during periods of heavy load, a more constant load on the generating apparatus is produced, with consequent better efficiency, and at the same time acting as a reserve in case of accident in the power plant. Unfortunately the battery is expensive, and a loss occurs in its operation which greatly reduces the higher efficiency secured by the increased load-factor. The great benefits obtained by its use are reserve capacity and voltage regulation, enabling the use of more efficient lamps."

Apart from the methods which may be employed to equalize the load, Mr. Archibald undertakes to examine, for a plant of an assumed maximum peak load, the effect which various load factors have upon the cost of the power produced. In doing this he divides the expenses involved in the cost of power into three elements; management; distribution; and production. The first of these, the cost of management, is practically constant for a given peak load, regardless of the load factor. The second element, the cost of distribution, does not vary, so far as the fixed charges and maintenance cost are concerned, but the losses in distribution do vary with the load factor, and as a rule will become a smaller percentage of the total the higher the load factor.

The principal element for consideration, therefore, is the effect of the load factor upon the actual cost of the production of energy.

In examining the cost of production the first cost of the plant involves an equipment sufficiently large to deal with the maximum peak load, and this is taken by determining the plant for a 100 per cent. load factor, and basing the interest, depreciation and other fixed charges upon this amount. The operating charges themselves are variable with the load factor, and may be divided into: labor, oil, and waste; supplies, water, and repairs; and fuel.

The cost of labor varies to a certain extent with the load factor, but the minimum number of men is reached at about 40 per cent. load factor, below which this item remains constant. The cost of oil and other supplies, as well as of water, and of repairs varies almost directly with the load factor, while the cost of fuel varies with some power of the load factor less than unity, depending upon the number and efficiency of the units employed.

Mr. Archibald gives in his paper a number of diagrams in which the various relations are plotted in the form of curves, for which the reader must be referred to the original, and from these some valuable deductions are drawn.

"The higher the load-factor the greater becomes the ratio of variable to fixed charges, and extra investment is advisable to secure the greatest economy possible. Extra investment in coal-handling apparatus and economizers will reduce the cost of labor and fuel in greater proportion than fixed charges are increased; the economizers also provide greater boiler capacity and purer feed water, reducing cost of repairs.

On the contrary when the load-factor on a system is low, the fixed charges are the governing factor in the cost of power, and extra expenditures must be carefully considered, particularly so if fuel is cheap."

Mr. Archibald goes into the influence of the load-factor upon the cost of management and of distribution to some extent, and gives curves illustrating these costs for certain conditions. This matter, however, is not one which can be so fully discussed as the cost of production, and cannot be so definitely treated. The question of the influence of the load-factor upon the cost of electric energy to the consumer is also briefly considered, and this curve bears a fairly definite relation to the others.

The paper concludes with a discussion of the relative value of steam and gas power for the generation of electricity, showing the necessity for attention to details if the full advantage of the higher efficiency of the gas engine is to be attained in its commercial application.

THE ELECTRO-METALLURGY OF IRON ALLOYS.

RECENT DEVELOPMENTS IN THE PRODUCTION OF HIGH-GRADE ALLOY-STEELS IN THE ELECTRIC FURNACE.

V. Englehardt—Stahl und Eisen.

ALTHOUGH much has been said about the practicability of using the electric furnace for the smelting of iron and the refining of steel, it has been realized that the element of cost must. at the present time, prevent such methods from entering into general competition with the older processes. At the same time there is a field in which the electric furnace can be employed where the question of the cost of the product is secondary to its quality, and for such work the electric furnace possesses numerous advantages. In recent issues of *Stahl und Eisen* there is given an account, by Herr V. Englehardt, of the progress which has been made in the practical operation of the Kjellin process for producing high-grade alloy-steels in the electric furnace, and some abstract of these papers will be found of interest.

The experimental researches of Kjellin have been conducted since 1899 at the Gysinge Iron Works, situated on the Dal-elf, about four hours by rail from Stockholm, in Sweden. These works operated a blast furnace, forge, and sulphite-cellulose works, this latter being the development of the facilities of the neighboring forest, and here in March, 1900, the first electric furnace, with a capacity for utilizing 78 kw. of electric energy, was put into active operation, turning out 270 kilogrammes of cast steel in 24 hours, with a consumption of about 7,000 kilowatt-hours of electric energy per metric ton of steel. This was soon improved by the production in a second furnace, of 600 to 700 kilogrammes of steel in 24 hours, with a consumption of 2,140 kilowatt-hours per ton. In July the cellulose works was destroyed by fire, and the energy that had been required for this portion of the establishment was diverted to the service of a third and still larger furnace, in which still more successful results have been obtained.

The Kjellin process is practically a reproduction of the crucible process of making steel by fusing the materials in such proportion as to give the required carbon content to the product without requiring any subsequent additions to the charge. The only differences are the substitution of electric methods of producing the required temperature, and the arrangement by which larger quantities can be handled than is practicable with the crucible process. Further, the Kjellin furnace is an induction apparatus, there being no contact of electrodes or any external parts with the charge, and hence there is no possibility for the introduction of any impurities, either solid or gaseous, so that the purity of the product is dependent entirely upon the purity of the material with which the furnace is charged.

The furnace itself is practically a step-down transformer, and the simplicity of its construction is marked. In an ordinary transformer the high-tension current passes through a coil of proper fineness, wound about an iron core, while around this again is wound the coil of heavier wire in which the induced current is produced when an alternating current traverses the outer coil. In the case of the Kjellin furnace the outer coil is replaced by an annular channel, or sort of gutter, formed in the refractory material of the furnace, the wire coil and its iron core being in a central space so arranged that a free circulation of air is permitted. The charge of metal in the annular trough or gutter forms the short-circuited outer winding, so to speak, of the transformer, and the heat generated in the mass of the metal is employed to effect the fusion of the combination. It is evident that the capacity of the trough may be made sufficient to hold the charge required, and that this ring-like crucible may be kept closely covered during the entire operation, the completed run of steel being drawn off by a tap hole into a ladle and poured into moulds as desired.

The latest furnace of this type differs from the earlier ones in dimensions only, the simplicity and effectiveness of design having been such as to render no radical changes or modifications necessary.

From the records of the works it appears that the output of a furnace is about 5,000 kilogrammes of steel in 24 hours, the power required being 167.1 kilowatts, or about 222 electrical horse power, giving 4010 kilowatt-hours per day, or 802 kilowatt-hours per metric ton of steel. Records for another day show a better result, the consumption of electrical energy being 770 kilowatt-hours per ton.

Herr Englehardt gives a very complete thermal analysis of the working of the furnace, showing that the theoretical consumption of energy should be 489 kilowatt-hours per ton of steel, so that the above performances indicate an efficiency of more than 60 per cent. for the actual process.

The current at Gysinge is at present derived from water power, and under these conditions it is maintained by Kjellin that the highest grade of crucible steel can be made at a lower cost than by the crucible process. It is suggested also that such furnaces may well be operated in connection with blast furnaces, the electrical energy being obtained from the waste gases of the blast furnaces, used in gas engines, thus furnishing a method of utilizing the power in the gas in an allied line of work instead of using it to generate electric current to supply an outside market.

The Kjellin process has also been used to work with pig and ore as well as with pig and scrap, and the results have been encouraging when a high grade of ore is employed.

It is evident that the economy of the process is dependent almost entirely upon the cost of the electrical energy, and computations for one locality cannot therefore be used for another unless the comparative cost of current is known. Data for a large furnace, to consume 1,000 h. p. are given for a daily production of 30 to 36 tons, from which it is computed that steel can be made for about 70 marks per ton, but practical operations have not yet been carried out on such a large scale.

ELECTRIC POWER IN SHIPYARDS.

THE COMPARATIVE ADVANTAGES OF ISOLATED PLANTS AND CENTRAL STATIONS IN CONNECTION WITH THE USE OF ELECTRICITY IN SHIPYARDS.

J. F. C. Snell—North-East Coast Institution of Engineers and Shipbuilders.

AMONG the various classes of manufacturing and engineering establishments to which electric driving may be applied, there appears to be no one for which electricity appears to be better adapted than the shipyard. In nearly every instance the tools and machines are widely separated from each other and from the source of power, while the opportunities for employing portable and semi-portable tools are many and important. In existing yards the problem of power distribution has been partially solved by the use of a number of steam engines, either directly connected to the tools or arranged to drive groups of machines in the immediate vicinity, but this system involves the carrying of steam over long distances, and demands the placing of engines in exposed and unsuitable locations, while the substitution of electric motors removes at once many of the power difficulties in this important department of engineering work.

In a paper recently presented before the North-East Coast Institution of Engineers and Shipbuilders by Mr. J. F. C. Snell, the application of electric power to industrial purposes in general and to shipbuilding establishments in particular, is discussed. Mr. Snell assumes that the desirability of using electric power is admitted, and that the principal question to be determined is simply the most desirable source from which the electric energy is to be obtained. In order to make an intelligent comparison between the relative advantages and costs of independent and co-operative generation of current, Mr. Snell gives first, in tabular form, the actual results of electrical stations operated by two large shipyards, one of which is partly driven by its own steam-driven plant, and partly from a town supply, while the other is supplied entirely from its own gas-engine driven plant. In these cases, allowing interest at 4 per cent. and depreciation at 5 per cent., the costs work out at 1.08d. per unit, or kilowatt-hour, for the first, and 1.173d. per unit for the second.

"The author has always contended that in works requiring from 300,000 to, say, 1,000,000 units per annum, and with a load factor of 20 to 30 per cent., the cost will be found to vary from 1.25d. per unit to 1d.; and he is of opinion that, looking at the question broadly and taking into due account an adequate depreciation of plant and average cost of upkeep for, say, a period of 20 years, 1d. is about the lowest limit for installations of the size stated He is aware, of course, that there are special cases in which, either through an abnormal and excellent load factor, or through the utilisation of blast-furnace gases, the cost is materially reduced below this figure. These, however, are quite the exceptions, and he affirms, without fear of contradiction, that the generality of installations will be found to have costs within the limits cited.

"As to the advantages of the works saving the capital expenditure; the responsibility involved in laying down their own plant, or the loss represented by the valuable space occupied; the incidental losses which result from having the machinery ready during many mornings in the year after holidays without the certainty of the men turning in, or during slack times; and the frequent special arrangements required to be made for working night shifts—all these items, which may be put to the credit of the outside power stations point of view, will be dealt with later in the paper.

"Now let us turn to the other side of the question, viz., supply to works from outside sources. Whether it be a power company like the Tyneside Power Company, or a municipal works such as Sunderland, what will be said will be true of most stations, and may be considered as generally applicable to all.

"The first and most obvious saving is in the capital outlay per kilowatt. Many independent plants do not exceed 200 kilowatts in extent, while the two power stations referred to have actually exceeded or are nearing 10,000 kilowatts. Now, if the smaller installation cost £45 per kilowatt installed —which figure includes buildings, boilers, engines, steam pipes, condensers, dynamos, and switchboards completely equipped on the one hand; or buildings and gas engines, water tanks, dynamos and switchboards completely equipped on the other hand, and also includes, for obvious purposes of safety, spare plant representing probably some 50 per cent. of the capacity of the running plant—it is obvious that the 10,000-kilowatt station, costing about £20 per kilowatt, can afford to spend money outside the station in laying adequate cables and fixing the necessary transforming machinery, and yet be able to effect a considerable saving on the capital sum.

"Secondly, it must be equally obvious that, while a decent load factor of anything between 15 and 35 per cent. even may be obtained in an independent installation, yet the combination of a dozen, and, *a fortiori*, several dozen such works in one station must result in a far better load factor, which is actually in practice found to be anything from 45 to 55 per cent. This improved load factor at the resultant station is owing to the non-synchronism of the various maximum demands on the several works, which among station engineers is known as the 'diversity factor.' This diversity factor really has a high value. The author knows examples where the resultant maximum load at a generating station is only some

60 per cent. of the integrated total of the maxima. This, obviously, means that a given amount of plant installed at the power station is able to deal with a much larger total of horse-power of motors installed in various works than the same plant could possibly deal with if it were split up into a number of small independent installations.

"As one is speaking to so many engineers who may not be specifically electrical, it would be well to define the term 'load factor,' as so much depends upon this, the most important detail after capital cost in producing economical results. The load factor of any plant, then, is the ratio of the actual units generated in any given time to the units which would be generated were the plant working continuously at full load during that time. For example: the number of hours in a year is 8760; an installation representing 100 kilowatts, working continuously for 8760 hours, would generate 876,000 units. If it is actually found that 219,000 units have been generated during the year, then the load factor of that plant has been $\frac{219{,}000 \times 100}{8760} = 25$ per cent.

"It must be clear to anyone that a steam dynamo of 100 kilowatts working continuously will cost less per kilowatt per annum than if only working more or less intermittently, or at varying loads, during a quarter of that time. Now, this is another of the advantages claimed for general sources of supply and is not based on mere hypothesis, but is actually proved from the results obtained, viz., the thereby increased load factor due to the supply given to several works, together with the practical diversity of their maximum loads, as before stated, enables the kilowatt or the horse power per hour—whichever basis be taken—to be more cheaply produced than if each works produced its own current."

By examining the costs of a large power station equipped with modern appliances, as well as the operative costs of various isolated plants, Mr. Snell obtained data from which he has plotted diagrams showing the relative prices of current supplied from a public station and from an isolated plant operated by the consumer. The results show that for a load factor below 50 per cent. there is a distinct gain in using the general supply station, while for load factors over 50 per cent. the isolated plant is the more economical. Since the character of the work done in shipyards is such that a load factor of 50 per cent. or more is not to be expected, 40 per cent. being as high as can well be attained, it appears that the power-supply station is the more desirable method.

Mr. Snell discusses the relative advantages of the direct and the polyphase current, and shows that notwithstanding the fact that the costs and weights of motors are in favor of the three-phase type the direct-current system has the advantages at present in point of efficiency, and appears likely to continue so for some time.

The subject of standardization comes in for discussion, and some very sensible advice in this connection is given.

"Wherever possible, it should be the aim to group the machinery and tools in such a way as to adopt three sizes of motor, and let us say, for example, 30 horse-power, 15 horse-power, and 5 horse-power. In this way a spare armature for each type of motor will probably be found to be sufficient, and thus the capital expenditure on spares will be considerably reduced.

"It is quite true that a complication ensues in many cases from the variety of speeds at which tools have to be driven, but the author does not think that this is as bad as is made out, and in special cases, rather than install a fourth size of motor, he would be inclined to modify the speed through gearing of some kind, even at the risk of some loss in efficiency Then, the starting switches, the switchboard panels, and instruments could be made, say, of two sizes to suit the three classes of motor, and thus there will be some system instead of the too frequent and too great variety of instruments one sees installed. In a system carefully laid out, the cables can also probably be arranged to be covered by two sections.

"The arc lamps should be, if possible, of the same pattern, and the resistance or choking coils in connection with them should be of precisely the same pattern. Thus a very simple and easily understood system will be adopted with a resultant minimum first cost. If continuous current dynamos be installed, the adoption of the three sizes suggested can also be probably arranged; and the same size of carbon brush—though a different number of each, of course—can be utilised, and thus only one size of carbon be kept in stock.

"All electrical users having a number of motors will find it convenient to have a small portable blower as an auxiliary, mounted on a trolley, and by means of which the motors can be thoroughly blown out from time to time. It is advisable, of course, to have a totally enclosed motor, although rather more expensive in first cost for the same temperature limit. Yet, even in this case it is advisable occasionally to have them thoroughly blown out and freed from dust.

"One of the greatest difficulties which manufacturers have is to ascertain the size of motor to attach certain machines. In any case, with direct current installations it is always advisable to have the motors compound wound, and in cases of intermittent work, such as with punching and shearing machines, as an extreme example, it is necessary to supplement the motor by a heavy fly-wheel. These are points, however, upon which it is advisable to get expert advice, and to enter into a discussion of the sizes of motors for various industries would require a paper in itself."

THE OSMIUM ELECTRIC LAMP.

PRACTICAL RESULTS WITH THE IMPROVED WELSBACH INCANDESCENT ELECTRIC LAMP WITH OSMIUM FILAMENT.

Fritz Blau—Elektrotechnische Zeitschrift.

WE noticed in these columns last month the improved tantalum incandescent electric lamp recently perfected through the labors of Dr. von Bolton and Dr. Feuerlein. We now have a paper by Herr Fritz Blau presented before the Elektrotechnische Verein in Berlin, and published in a recent issue of the *Elektrotechnische Zeitschrift*, giving an account of the progress which has been made with the osmium lamp of Dr. Auer von Welsbach, already well known by reason of his invention of the incandescent gas mantle.

Herr Blau calls attention to the fact that before succes was attained with the carbon filament for incandescent electric lighting experiments were made with drawn platinum wire, but that this material failed to give sufficient durability, and was wholly displaced by carbon.

Of late years attempts have been made to find some material which would stand a higher temperature than the carbon filament, and enable a better efficiency and a higher illuminating power to be obtained. According to the so-called law of Stefan the total amount of energy radiated by a heated body is proportional to the fourth power of the absolute temperature. Increase in temperature also causes a rapid increase in the proportion of short waves as compared with long waves, this rate being stated by Herr Blau to increase with the fifth power of the temperature. The increase in proportion of short waves is much more rapid for bodies with a smooth metallic lustre than for black bodies, and hence it is evident that the improvement in the efficiency in incandescent lamps depends upon the use of a metallic filament in place of carbon. Among the metals available for the purpose only tantalum and osmium appear to offer practical possibilities. The results which have been obtained with tantalum we have already noticed, while the paper of Herr Blau shows how the difficulties encountered in the employment of osmium have been largely overcome.

Dr. von Welsbach found that it was impossible to draw metallic osmium in the form of wire, on account of the brittleness of the metal, and he therefore attempted to coat a fine platinum wire with osmium and then to evaporate the platinum, leaving the osmium behind. Practical difficulties were encountered with this process, principally owing to the formation of a fusible platinum-osmium alloy, and a new process had to be devised. This process consisted in the formation of a paste consisting of finely powdered osmium with an organic binder, the mixture being forced through a die to form a filament, subsequently dried and carbonized. The dried filament was then subject to the process of forming, which consists in placing the porous filament, which contains a large proportion of carbon, in a vessel containing vapor of water, together with a certain proportion of reducing gases. Here the filament is heated to incandescence by the passage of an electric current, the result being the repetition, on a small scale, of the well-known process for the production of water gas. The steam is dissociated to oxygen and hydrogen, and the carbon is removed by conversion into carbon monoxide and dioxide, while the hydrogen converts the crude osmium into a metallic filament, practically pure, although still somewhat porous, the surface being somewhat rough. The ends of the filament are then fused by the electric arc to platinum terminals and enclosed in a bulb from which the air is exhausted, similar in general appearance to the carbon-film lamp.

The early lamps could stand only a low voltage, the first on the market being made for 37 volts, but more recently lamps of higher voltage, up to 110 volts have been perfected. The filament of a 37 volt lamp, of 25 Hefner candle-power, is about 280 millimetres long, and is arranged in four loops, the diameter of the filament being 0.087 millimetre. Such a lamp has a life of 5,000 hours, but the useful life may be taken at about 2,000 hours, during which time the illuminating power does fall more than 20 per cent. from the original. Since the resistance increases with the temperature, an increase in voltage of 10 per cent. gives an increase of only 6.5 per cent. in current, while for the ordinary carbon filament the current increase is 12 per cent. The corresponding increase in illumination for the osmium lamp is about 40 per cent. and for the carbon lamp 80 per cent., so that changes in the voltage have a smaller effect upon the light with the osmium than with the carbon lamp.

Apart from the longer life, the osmium lamp is nearly double the efficiency of the carbon lamp, the consumption of energy being about 1.5 watts per candle, as against 3 watts per candle for the carbon lamp. It will therefore be possible, simply by a change of lamps, to secure double the light from the same consumption of current, a feature which should cause a rapid introduction of the new lamp, and a large increase in the employment of electric lighting.

As at present constructed, the osmium lamp is rather more fragile than the carbon lamp, but the difference is slight, and the lamps appear to stand the shocks and vibrations of railway service well.

The activity which has appeared of late in the improvement of incandescent electric lighting is most encouraging. For many years the carbon lamp was used without any material improvement in efficiency or illumination being afforded. Then came the Nernst lamp, followed by the osmium and the tantalum lamps, and should any of these newcomers fulfil their present promise some improvement in the carbon lamp must be made if it is to stand against the superior advantages of its later rivals. So far the improvements have all come from Germany, although other countries have not been slow to take up with the new devices, but the present stimulus should be sufficiently powerful to bring out other improvements elsewhere.

ELECTRICITY AND ENGINEERING.

AN ADDRESS TO STUDENTS UPON THE VALUE TO ENGINEERS OF THE STUDY OF THE THEORY OF ELECTRICITY.

James Swinburne—Institution of Civil Engineers.

IT is now very generally agreed that theory is not to be despised as an aid to the conduct of practical work, and the ancient prejudice against the man who really tried to find out the fundamental principles of the art he endeavored to follow for a livelihood is beginning to die out. This state of affairs accounts for the fact that instruction to young men, students and others, in the theory of the various branches of engineering which they propose to enter is now looked upon with approbation, and considered as really of value to them as a portion of their preparation for practical life.

An interesting example of the valuable instruction now given to students by men who have attained high reputations in engineering work is found in the address recently delivered to the student members of the Institution of Civil Engineers by Mr. James Swinburne, treating of the theory of electricity and the value of its study to engineers.

Mr. Swinburne discusses first the subject of mathematics, and its importance as a foundation, and makes some excellent points as to the fact that mathematics should be regarded only as an instrument of value in proportion as it is applied to useful work. The present methods of teaching mathematics have come down from the time when it was dealt with as an abstract study, rather degraded than otherwise by being put to any practical application, but it is undoubtedly much better to learn mathematics by studying mathematical physics, using the text books rather as commentaries. Under the older methods the mathematician is strongly tempted to make the data of his problems fit the limitations of his mathematics, while in engineering the data have an annoying manner of declining to stay neglected, and the computed results must always stand the test of inflexible comparison with the completed work. At the present time, unfortunately, the applications of some of the mathematical methods most useful in electrical work, such as the vectorial analysis, are impeded by minor differences in notation, which Mr. Swinburne rightly suggests might well be referred for standardization to a committee of competent mathematicians, such as the committee of the British Association.

Apart from the study of the theory of electricity as an application of mathematics, the practical experience gained in the use of the centimetre-gramme-second system is of much value. In this connection, Mr. Swinburne makes some characteristic comments upon the rival systems of measurement.

"I will not attempt to discuss the commercial or technical aspects of the rival claims of the decimal and vulgar fraction; of the metre and the inch, as standards of length; or of the derivation of other units from those of length, mass and time on the one hand, or from independent standards, as in popular use. The three questions are totally distinct, but they are generally discussed as if they were all one. For unapplied scientific work it is of enormous advantage to adapt the decimal system, and the derivation of other units from those of length, time and mass. What are chosen as units of length, time and mass is unimportant. The metre, second and gramme are purely arbitrary choices. The metre is not a round decimal fraction of anything in particular. The second is not a round decimal of a day or year, and the gramme involves water which is not more standard than anything else. This matters little; the "C.G.S." system is invaluable in scientific work, and electricians have developed it infinitely more than any one else, and electrical engineering is the only industry in which the system is really used. It is enormously difficult to get a systematic and satisfactory system of units, and even electricians have got into some confusion. For one thing they got their standard ohm and volt more than 1 per cent. wrong, and the alteration was expensive and troublesome.

"I will now pass from the mathematics of electrical physics to the physical ideas at the base of electrical theory. During the last few years a profound change has come over the face of the physics of ultimate matter, owing to the advent of the electron hypothesis. Matter is supposed to be made up of molecules, which are composed of atoms. The atoms contain very much smaller bodies called electrons, each consisting of a minute particle of matter charged with a definite quantity of electricity, or consisting of the charge of electricity without the matter. Some regard the existence of electrons as a sort of theological dogma, others as a statement of fact, others as a sound theory, others as a working hypothesis, and many more as a curious speculation. But there is no doubt that the idea is of far-reaching importance. The vital point for us is that, like molecules, atoms, and ether, the electron is an invaluable aid to thinking straight. Whatever else it may be matters little. But it is by no means merely electrically that it is of importance; it involves a more or less complete reconstruction of our ordinary conceptions of the ultimate constitution of matter. Electricity bids fair to become the sovereign physical science, mechanics, heat, light, and chemistry being vassal subjects. Nothing I can say would therefore be an exaggeration as to the importance of the study of the new theory of the universe. The only difficulty at present is that the subject is so new that there is a want of books which give any clear account of it. What is urgently needed is a treatise which begins by assuming the existence of electrons, and gives a clear account of what the author conceives them to be, and then goes on to explain how they explain phenomena, and unravel all sorts of tangles, and open all sorts of strange doors of which the hypothesis is the unexpected master-key.

"So far, except in the case of the theory of electrons, I have been dealing with the indirect advantages of studying the theory of electricity; but before I come to the direct advantages, I must call attention to a feature of electrical engineering. It is an industry of exact calculation, and of exact measurement. To make accurate measurements, accurate standards and accurate means of comparison are needed. The electrical engineer is singularly badly off in the matter of standards. The standard of resistance is the most permanent, and it might be supposed that nothing is easier than to make and adjust a resistance-coil that would remain the same for all time. Perhaps the chief difficulty arises because electricians generally use alloys. Pure materials vary in resistance with temperature, and they are put on one side in favour of alloys which have small temperature-coefficients and high specific resistance. Such specific resistance is not really at all important. Many alloys undergo gradual internal changes, and a very slight change may make a very considerable variation in the specific resistance. The theory of alloys may put us in possession of resistance standards that will not vary; at present it is well known that certain alloys are by no means in a state of internal equlibrium, so that they go on slowly altering spontaneously. The standard of electrical pressure is a cell which has to be made up according to prescription. Each experimenter uses his own prescription. If a committee were formed to try one another's prescriptions it might be possible to select one as a standard. The other standards can be derived from those of resistance, pressure, and time. It is clear that the electrical industry is rather unfortunate in the matter of standards, compared with mechanical engineering, which has its standards of length and weight which are practically interchangeable and easily copied."

The development of electrical engineering has been of immense value to other departments of engineering work, especially in the ability to make precise and reliable measurements of quantities previously very difficult to handle. In the transmission of power by shafting, pulleys, and belts or ropes, the losses were both large and indeterminate. With electrical transmission the losses have been greatly reduced, and are in any case capable of very accurate competition beforehand.

The measurement of power developed by a steam engine may be made by the use of the indicator, but this involves many sources of error, and does not include the internal losses in the engine itself. If, however, the engine is used to drive a dynamo, the output can be determined very readily and accurately, while the input of steam can be readily measured, the efficiency of the whole plant being thus obtainable. Again, the use of the electric motor enables the power consumed by the machines driven to be measured with ease and accuracy, and the resulting information has been of immense value in the improvement and development of machine tools and processes.

Mr. Swinburne enumerates many useful applications of electricity, these serving largely as examples of his contention that a knowledge of the theory and practice of this important department of engineering work is of great value to the student and engineer in every department of practice. In power transmission, in mining, in electric-chemistry and metallurgy, and in nearly every department of work electricity is of great importance, and there is no doubt that: "a modern engineer cannot consider his technical equipment complete without some knowledge of the theory of electricity."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch Repairs.

Description of the Method of Repairing an Arch of 12 Metres Span (Notice Explicative sur la Méthode Suivie pour Réparer un Pont de 12 Metres d'Ouverture). M. Jouvion. Describing the manner of injecting mortar into the joints of an arch which had become weakened by the settling of an abutment. 1200 w. Revue Technique—Feb. 25, 1905. No. 68428 D.

Blackwell's Island.

The Erection of the Blackwell's Island Bridge. An illustrated detailed description of this bridge from East 59th St., Manhattan, over Blackwell's Island to Ravenswood, and the methods of erection. 2500 w. Eng Rec—March 4, 1905. Serial. 1s part. No. 68182.

Brooklyn Bridge.

A Study of the Brooklyn Bridge Problem. Edward Whitehead Curtiss. Illustrates a system of transportation for reducing the load on the bridge and distributing it more uniformly and overcoming the congestion at the terminal. 1500 w. Sci Am—March 18, 1905. No. 68327.

Concrete Arches.

New Concrete Arches on the Lake Shore & Michigan Southern Railway. Illustrates and describes the bridge over Chagrin River, at Willoughby, Ohio; and the bridge at Angola, N. Y. 1200 w. Ry Age—March 24, 1905. No. 68670.

Erection.

The Erection of the Missouri River Bridge at Plattsmouth, Neb. F. T. Darrow. Illustrates and describes the method of erecting a renewed bridge 1,658 ft. long, on the C. B. & Q. system, without interrupting traffic. 3500 w. Eng Rec—March 4, 1905. No. 68184.

The Erection of the Quebec Bridge. An illustrated description of the longest span bridge undertaken in any country. 5200 w. Eng Rec—March 4, 1905. No. 68194.

Expansion.

Methods of Expansion of Railway Bridges. Francis S. Rice. Outlines a few of the methods providing for temperature changes and expansion in railway bridges. Brief discussion. 2000 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68572 D.

Floors.

Cushioned Floor Beds for Railroad Bridges. Gives experience in the use of granulated cinder. General discussion. 2200 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68573 D.

The Abandonment of Wooden Floors for Suspension Bridges (La Suppression du Bois dans les Tabliers des Ponts Suspendus Modernes). G. Leinekugel LeCocq. Data and results of experiments showing the superiority of reinforced-concrete floors over wood. 2000 w. Génie Civil—Feb. 18, 1905. No. 68413 D.

Holland.

The Bridge over the Maas at Spijkenisse (Le Brug over de Oude Maas nabji Spijkenisse). A. L. de Gelder. Illustrating and describing a new railroad bridge with three through trusses of 83.7 metres span, and one draw span with openings of 25 metres. 3000 w. De Ingenieur—Feb. 18, 1905. No. 68708 D.

Piers.

Construction of the Thebes Bridge Piers. Illustrated description of the construction of the piers for a long bridge across the Mississippi River at Thebes. 1400 w. Eng Rec—March 4, 1904. No. 68191.

Reconstructing Piers of a Railroad Bridge in Service. Illustrates and describes a difficult piece of substructure work involving the replacing of two piers and repairing one abutment of a railroad bridge under traffic, at Terre Haute, Ind. 2500 w. Eng Rec—March 4, 1905. No. 68188.

See also Civil Engineering, Construction.

Plate Girders.

Plate Girder Webs. States briefly the difficulties in forming a really satisfactory formula, and gives reasons for adopting the one selected. 5300 w. Engr, Lond—March 17, 1905. No. 68666 A.

The Reconstruction of the Baltimore and Ohio Railroad Bridge Over the Ohio River, at Benwood, West Virginia. J. E. Greiner. Describes the old bridge, and the reconstruction, which was done in sections, extending over a number of years. 3 plates and ills. 2200 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68575 E.

Reinforced Concrete.

Reinforced Concrete Piers of the Gilbertsville Bridge. Illustrated description of piers 60 to 71 ft. high from bottom of footing to top of coping. 800 w. Eng Rec—March 4, 1905. No. 68192.

See also Civil Engineering, Materials of Construction.

Standard Bridges.

Standard Bridges on the Harriman Lines. Complete specifications, plans, &c., with explanatory remarks. 4500 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68375.

Suspension.

A Note on Early American Suspension Bridges. Notes aiming to fix as definitely as possible the claims of certain inventors in connection with the first introduction of suspension bridges. 1500 w. Eng News—March 16, 1905. No. 68335.

A Rational Form of Stiffened Suspension Bridge. J. Melon. Continued discussion of paper by Gustav Lindenthal, on this subject. 1500 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68576 E.

The Monongahela River Suspension Bridge at Morgantown, W. Va. W. H. Boughton. Illustrated account of a bridge similar to the one that failed recently at Charleston, W. Va., and about the same age, which is not considered entirely safe. 1100 w. Eng News—March 9, 1905. No. 68275.

Swing Bridge.

A New Swing Bridge at Copenhagen, Denmark. H. C. V. Moeller. Illustrated detailed description of a combined highway and double-track railway bridge, consisting of one center-bearing draw span and six deck plate-girder spans, with one roadway and two sidewalks. 2500 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68574 E.

Viaducts.

The Erection of the Kentucky River Viaduct in 1877. Joseph H. Springer, Sr. Outlines briefly the methods adopted in constructing this structure, which carries the Cincinnati Southern Ry. across the Kentucky River. Ills. 2400 w. Eng News—March 23, 1905. No. 68586.

The Reconstruction of the Portage Viaduct. Illustrated explanation of the method of reconstruction without interrupting traffic. 2200 w. Eng Rec—March 4, 1905. No. 68187.

The Viaduct of Fades. Emile Guarini. Illustrates and describes some interesting features of a great viaduct, having a length of 1,446 ft. being constructed in the south of France. It is remarkable not only for its dimensions, but for the original arrangements. 1800 w. Sci Am Sup—March 4, 1905. No. 68120.

Viaduct across the Seine at Paris (Viaduc sur la Seine à Paris). An illustrated description of the new bridge across the Seine above the Austerlitz bridge, for the Paris Metropolitain. 1800 w. 1 plate. Revue Industrielle—Feb. 25, 1905. No. 68717 D.

Washington, D. C.

Connecticut Avenue Bridge, Washington, D. C. An illustrated article showing the progress made on this structure during the past year, the methods of construction, etc. 1000 w. Ry Age—March 24, 1905. No. 68675.

CONSTRUCTION.

Acoustics.

The Acoustics of Public Halls and an Instrument for Investigation (Ueber die Akustik von Hörsälen und ein Instrument sie zu Bestimmen). Sigm. Exner. A study of the distribution of sound and the production of echoes and interference in public auditoriums. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—March 10, 1905. No. 68462 D.

Bins.

Determining the Capacity of a Cylindrical Grain Bin with Eccentric Conical Hopper. B. F. Groat. Gives a general formula and method. 600 w. Eng News—March 9, 1905. No. 68279.

Building Construction.

Steel Work in the New York Hippodrome. Illustrates and describes this feature in the construction of this large fireproof building for amusement purposes. 2000 w. Eng Rec—March 25, 1905. No. 68630.

The Construction of the Farmers' Bank Building, Pittsburg. An illustrated description of rapid building operations. A 24-story steel-cage office building with basement and sub-basement was erected and occupied in less than one year. 2400 w. Eng Rec—March 18, 1905. No. 68396.

The New Times Building. Illustrated detailed description of the design and construction. 4000 w. Archts & B'ldrs' Mag—March, 1905. No. 68296 C.

The New York Hippodrome. Illustrated description of the largest building of its kind in the world, recently built in New York. Principally describes the mechanical features of the stage. The building seats 5,300. 1800 w. Sci Am—March 25, 1905. No. 68597.

Cofferdam.

Sheet Pile and Canvas Cofferdam for a Large Concrete Pier. J. C. Hain. An illustrated article describing conditions and the methods used. 1400 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68377.

Concrete Piles.

Concrete Piles at the United States Naval Academy. Walter R. Harper. Illustrates and describes foundation work of the academic building at Annapolis, Md. 2400 w. Eng Rec—March 4, 1905. No. 68196.

Dam.

Completing the New Croton Dam. An illustrated description of methods of closing the river tunnel which had been left to provide for the passage of the normal flow of the Croton River. 3200 w. Eng Rec—March 4, 1905. No. 68195.

Embankments.

Concrete and Puddle for Reservoir Embankments. William Watts. Information on the use of concrete for this purpose, the comparative cost of puddle and concrete trenches, the mixing, &c. 4000 w. Cement—March, 1905. No. 68609.

Excavating.

A New Style of Scraper Excavator. Illustrates and describes an excavator consisting of a scraper or bucket of special design, handled by a derrick mounted upon a car or scow. 600 w. Eng News—March 2, 1905. No. 68110.

Modern Machinery and the Panama Canal. A. W. Robinson. Mr. Robinson's first article deals with methods and costs of previous works, discussing the extent to which they can safely be used as guides for the work at Panama. 3500 w. Engineering Magazine—April, 1905. No. 68720 B.

Fireproofing.

An Important Test of Fireproof Construction. Gives the official report of Prof. Ira H. Woolson of a test made in a Pittsburg warehouse. Ills. 1800 w. Br Build—Feb., 1905. No. 68153 D.

Two Interesting Examples of Fireproof Construction. Brief illustrated descriptions of double houses lately built in Pittsburg; and the Campania apartments, built in Akron, Ohio. 1000 w. Br Build —Feb., 1905. No. 68154 D.

Foundations.

The Foundations for the Hotel Albert, New York. Describes difficult foundation work, because of quicksands encountered in building an extension to this hotel. Ills. 2000 w. Eng Rec—March 11, 1905. No. 68266.

Galveston.

Raising the Grade of Galveston. Map, with description of unusual hydraulic dredging and filling work. 2200 w. Eng Rec—March 11, 1905. No. 68263.

Masonry.

Masonry. Abstract of report at meeting of the Am. Main. of Way Assn. On the use of concrete and reinforced concrete, its adaptability, specifications for cement, &c., with discussion. 8500 w. Ry Age—March 24, 1905. No. 68682.

Mill Construction.

The Underwriters' View of Some Failures of Construction. F. Elliot Cabot. Read before the Boston Soc. of Archts. Discusses the weaknesses in mill construction, and fireproof construction. 2000 w. Am Archt—Feb. 25, 1905. No. 68070.

Pillars.

Recent Studies and Experiments on the Resistance of Pillars (Neue Studien und Versuche über die Tragkraft der Säulen). Prof. Bernhard Kirsch. A comparison of the formulas for the buckling of columns with experiments on small rods in the testing machine. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 17, 1905. No. 68458 D.

Race Course.

Engineering Features of Belmont Park. General plan and description of interesting engineering features of a fine race course near New York. Ills. 3300 w. Eng Rec—March 11, 1905. No. 68268.

See Civil Engineering, Materials of Construction.

Roof Trusses.

The Erection of the New York Hippodrome Roof Trusses. Illustrates and describes the method of erection by means of a special timber tower and its booms. 1200 w. Eng Rec—March 18, 1905. No. 68398.

Simplon Tunnel.

Hydraulic Rock-Borer. An illustrated detailed description of the Brandt hydraulic rock drill, the principal machine employed in boring the Simplon Tunnel. 1300 w. Engr, Lond—Feb. 24, 1905. No. 68224 A.

The Completion of the Simplon Tunnel. Charles R. King. The first of a series of extensively illustrated articles. The present number deals principally with the difficulties due to encountering hot springs. 2500 w. Sci Am Sup—March 25, 1905. Serial. 1st part. No. 68599.

The History of the Simplon Undertaking (Zur Geschichte des Simplon-Unternehmen). S. Pestalozzi. A general history of the various projects which resulted in the boring of the Simplon tunnel. Serial. Part I. 1800 w. Schweiz Bauzeitung—March 4, 1905. No. 68498 B.

The Perforation of the Simplon (Il Traforo del Sempione). A comprehensive review of the Simplon tunnel works, in connection with the announcement of the meeting of the headings. 3000 w. L'Industria—March 12, 1905. No. 68712 D.

The Piercing of the Simplon (Il Traforo del Sempione). N. Sacerdoti. A review of the undertaking in view of the completion of the perforation, with comments on the salient features of the work. 1800 w. Il Monitore Tecnico—Feb. 28, 1905. No. 68711 D.

The Simplon Tunnel. Editorial review of this great engineering work, its difficulties and interesting features. 3500 w. Engng—Feb. 24, 1905. No. 68222 A.

The Simplon Tunnel. The first of a series of articles describing the difficulties encountered and overcome, especially those due to the influx of large quantities of hot water. 2800 w. Engr, Lond—March 3, 1905. Serial. 1st part. No. 68315 A.

Subways.

See Civil Engineering, Municipal.

Tunnels.

Reinforced Concrete Tunnel on the Southern. Illustrated detailed description of the construction of a tunnel at South Knoxville, Tenn. 450 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68368.

Some Proposed Alpine Tunnels. Information, with map, concerning a new railway line from Genoa to Paris, and the tunnels that would have to be bored. Also a route from Genoa to Tartona, with the Rigoroso tunnel. 1600 w. Engr, Lond—March 17, 1905. No. 68668 A.

See also Simplon Tunnel.

MATERIALS OF CONSTRUCTION.

Brick.

Paving Brick, Testing and Inspection. Arthur N. Talbot. Read before the Illinois Clay Workers' Assn. Considers requirements and tests, some of the methods used for different grades of brick, &c. 2800 w. Munic Engng—March, 1905. No. 68351 C.

Cement.

British Standard Specifications for Portland Cement. Gives the specifications recently adopted by the Committee on Cement of the Engineering Standards Committee of Great Britain. 1500 w. Eng News—March 2, 1905. No. 68117.

Disintegration of Portland Cement Briquettes by Oil and Experiments to Prevent It. James C. Hain. A report of experimental investigations and the results. Ills. 4000 w. Eng News—March 16, 1905. No. 68339.

Review of an Article by Eduard Jordis and Erhard H. Kanter, on the Historical Development of the Theories Concerning the Constitution of Portland Cement. Published in the *Zeitschrift für Angewandte Chemie*, Berlin. 3300 w. Cement Age—Feb., 1905. Serial. 1st part. No. 68083.

Slag and Portland Cements (Ueber Schlacken und Eisen-Portlandzement). Fritz Hromatka. A comparison of the properties of slag cement with those of the so-called "iron" Portland cement and ordinary Portland cement, discussing their respective applications. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 25, 1905. No. 68707 D.

The Development of the Portland Cement Industry in the United States (Die Herstellung von Portlandzement in den Vereinigten Staaten von Amerika). A. Heller. With plans of recent works and details of the equipment. 3000 w. Zeitschr d Ver Deutscher Ing—March 11, 1905. No. 68445 D.

Cement Works.

The National Portland Cement Works, Martin's Creek, Pa. Begins an illustrated detailed description of works of unusual interest in several respects. 2500 w. Eng Rec—March 11, 1905. Serial. 1st part. No. 68264.

Clays.

The Useful Properties of Clays. Allerton S. Cushman. The present article considers the formation of clays, and the kinds; their plasticity, binding power, tensile strength, slaking, and air shrinkage. 3000 w. Brick—March, 1905. Serial. 1st part. No. 68295.

Concrete.

Safeguards for Laying Concrete in Frosty Weather. Describes methods used in constructing large buildings of reinforced concrete near Rochester, N. Y., in winter weather. 2000 w. Eng Rec—March 4, 1905. No. 68185.

The Cost of Concrete Deposited in Molds Under Water for a Pier at Superior Entry, Wis. Abstract from the report of the Chief of Engineers, U. S. A., giving the methods and cost of building the concrete south pier, 3,023 ft. long. Ill. 2000 w. Eng News—March 2, 1905. No. 68118.

Preservatives.

Preservatives for Stone Walls. F. S. Hardesty. Discusses the cause of dampness and decay, and various processes for preserving walls of stone, brick, or concrete. 2500 w. Ice & Refrig—March, 1905. No. 68179 C.

Reinforced Concrete.

Aims and Scope of Laboratory Tests of Reinforced Concrete. Prof. F. H. Constant. An account of aims and methods and the work being accomplished. 4500 w. Munic Engng—March, 1905. No. 68354 C.

Concrete-Steel Construction. C. A. P. Turner. An illustrated article considering the action of concrete with steel, the function of each in the combination, the problems presented by beams, slabs and columns separately, and the mixture of concrete, and the cost. 1800 w. Jour Assn of Engng Socs—Feb., 1905. No. 68685 C.

Construction of the Schuylerville Concrete Dam and Power House. Illustrated detailed description of the construction of a two-story power house and pulp mill with concrete floors and walls and steel beams and columns, five steel and concrete penstocks, a hollow dam, abutments, wing walls and bulkheads. 1500 w. Eng Rec—March 4, 1905. No. 68193.

Description of Concrete-Steel Water Tower and Standpipe at Fort Revere, Hull, Mass. Leonard S. Doten. Read before the N. E. W.-Wks. Assn. Illustrates and describes this structure, constructed by the Government in connection with the water supply system for this military post. 1800 w. Cement Age—Feb., 1905. No. 68082.

Economical Construction of Reinforced Concrete Beams and Floor Slabs. Charles R. Steiner. Gives a table, submitted as a fair review of the most suitable sizes for varying maximum moments, with explanatory notes. 800 w. Eng News—March 9, 1905. No. 68280.

Experiments on Reinforced Concrete Pipes Made for the U. S. Reclamation Service. J. H. Quinton. An illustrated account of experiments made at Los Angeles, Cal., to determine if a more durable material than steel or wood could be used to carry water in pressure pipes across long depressions on canal lines. 1300 w. Eng News—March 9, 1905. No. 68273.

High Reinforced Concrete Retaining Wall Construction at Seattle, Wash. C. F. Graff. Illustrates and describes the methods of design and construction. 2200 w. Eng News—March 9, 1905. No. 68281.

Masonic Temple of Reinforced Concrete Construction at Toledo, O. Illustrated detailed description. 1200 w. Eng News—March 16, 1905. No. 68340.

On the Question of Concrete and Imbedded Metal (Subject IV. for Discussion at the Seventh Session of the Railway Congress). J. F. Wallace. Report (No. 3) for America. 32000 w. 10 tables and figs. Bul Int Ry Cong—Feb., 1905. No. 68382 E.

On the Question of Concrete and Imbedded Metal (Subject IV. for Discussion at the Seventh Session of the Railway Congress). W. Ast. Report (No. 2) for all countries except America and Russia. 22400 w. 4 tables and figs. Bul Int Ry Cong—Feb., 1905. No. 68381 E.

On the Question of Concrete and Imbedded Metal (Subject IV. for Discussion at the Seventh Session of the Railway Congress). Serge de Kareischa. Report for Russia. 18300 w. 10 tables. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68621 E.

Reinforced Concrete Medical Laboratory: Brooklyn Navy Yard. Illustrated description of this building. The walls are of brick, the floors, interior columns and roof of reinforced concrete. 1400 w. Eng News—March 23, 1905. No. 68585.

The Construction of the Steel-Concrete Shops at Beverly, Mass. Illustrated detailed description of the construction of buildings for the new plant of the United Shoe Machinery Co. 3000 w. Eng Rec—March 4, 1905. No. 68189.

The Design of Reinforced Concrete Beams from the Economic Point of View. Translation of an article by E. Elwitz, published in *Beton und Eisen*, on the design of rectangular and tee-shaped reinforced-concrete beams, arranging the formulas so as to facilitate, by the aid of tables, the most economic arrangement of proportions. 2000 w. Cement—March, 1905. Serial. 1st part. No. 68608.

The Robert Gair Reinforced-Concrete Factory and Warehouse. Illustrated description of a building under construction in Brooklyn, N. Y. 1400 w. Eng Rec—March 4, 1905. No. 68197.

Visintini Reinforced Concrete Construction, Textile Machine Works, Reading, Pa. Leon S. Moisseiff. Illustrated description of a four-story building nearing completion for The Textile Machine Works, of Reading, Pa., on a system used for the first time in this country. 2200 w. Eng News—March 2, 1905. No. 68111.

See also Civil Engineering, Bridges.

Reinforcement Rods.

Waved-Iron Bars (Welleneisen). Alexander Sattman. Describing an improved form of rod with corrugated ribs, especially adapted for use in reinforced concrete, by reason of the impossibility of slippage. 1200 w. Stahl u Eisen—March 1, 1905. No. 68441 D.

Specifications.

Recent Work in Unifying Specifications for Engineering Materials. J. Parker Snow. An account of the work being done on these lines in this and other countries. 800 w. Jour Assn Engng Soc's—Jan., 1905. No. 68349 C.

Timber.

Some Common Defects in Timber and Their Causes. Harold Busbridge, in *Technics*. The present article deals exclusively with those essential parts of a tree which are generally looked upon as blemishes by those who use the timber for structural purposes. Ills. 2800 w. Sci Am Sup—March 25, 1905. No. 68600.

MEASUREMENT.

Loading.

New Data on the Weight of a Crowd of People. Lewis J. Johnson. An account of experimental investigations, with illustrations, proving that the weight often reaches above 150 lbs. per sq. ft. 1800 w. Jour Assn Engng Soc's—Jan., 1905. No. 68348 C.

Photo-Surveying.

The Rapid Preparation of a Topographical Map by the Aid of Photography (Sur Une Carte Topographique d'une Assez Grande Etendue Levée en tres Peu de Temps à l'Aide de la Photographie). A. Laussedat. Describing important photo-surveying work about Mount Argaeus, in Asia Minor. 2000 w. Comptes Rendus—Feb. 13, 1905. No. 68419 D.

Stream Gaging.

River Discharge, Mean Velocity, and Cross-Sectional Area Curves. F. W. Hanna. Abstracted from a paper presented at the Hydrographic Conference of the U. S. Geol. Survey. Explains methods of obtaining these curves. 1800 w. Eng News—March 23, 1905. No. 68581.

Theodolite.

A Special Theodolite for Tunnel Cross-Sections and General Tachymetry. Illustrated description of an instrument that has been used extensively in taking cross-sections of the Simplon tunnel. 1200 w. Eng News—March 2, 1905. No. 68112.

MUNICIPAL.

Boulevard.

The Construction of Section 2, Riverside Drive Extension, New York. An illustrated article giving information of this drive between 135th St. and 145th St. 1500 w. Eng Rec—March 25, 1905. No. 68628.

Macadam.

Cost of Maintaining Macadam Streets. Gives some definite figures as to cost, and a statement of the condition of the streets at Pawtucket, R. I. Ills. 1500 w. Munic Engng—March, 1905. No. 68353 C.

Pavements.

Brick Pavements for Villages. Le Grand Brown. The first of a series of articles on street pavements in small towns. The present number gives an illustrated description of the street improvements in Canandaigua, N. Y. 1600 w. Munic Jour & Engr—March, 1905. No. 68257 C.

Joint Fillers for Brick Pavements. Ira O. Baker. Read before the Illinois Clay Workers' Assn. Considers sand, tar, asphalt, and cement as fillers, favoring the last. 2400 w. Munic Engng—March, 1905. No. 68352 C.

Roads.

Oiled Roads of California. Extracts from a recently issued bulletin, with photographs showing the conditions of the roads and samples of work. 3500 w. Munic Engng—March, 1905. No. 68350 C.

Secrets of the Good Roads of France. William Ballantine. Considers methods of construction, materials, repairs, maintenance, traffic, &c. 2700 w. Automobile—March 11, 1905. No. 68254.

Sewage Disposal.

The Sewage Disposal Works at Saratoga, N. Y. F. A. Barbour. Explains the conditions to be met, and gives an illustrated detailed description of the plant and its construction. It includes a new main sewer, the building of a small pump well and pumping station, the lifting of the sewage 15 feet by centrifugal pumps, the laying of a 9,000 foot force main, the building of a septic tank of 1,000,000 gals. capacity, and the construction of 18 acres of sand filters. 9500 w. Jour Assn of Engng Socs—Feb., 1905. No. 68684 C.

Sewers.

A Traveling Form for Constructing the Invert of Concrete Sewers. Robert R. Evans. Illustrated description, giving information in regard to its use, advantages and cost of work where it was used. 2000 w. Eng News—March 9, 1905. No. 68278.

Construction of Part of the Intercepting Sewers of Chicago. W. A. Shaw considers the section lying east of the Illinois Central railway tracks, between 39th and 51st Sts.; and a paper from the late Guy Miltimore considers the section between 51st and 63d Sts. Ills. Short general discussion. 10000 w. Jour W Soc of Engrs —Feb., 1905. No. 68094 D.

Sewer Ventilation at Winnipeg, Man. A report of particular interest, made by Mr. Allen Hazen, in which he recommends that the sewers be ventilated through the house soil pipes, as investigations have shown that disease cannot be carried by the air of sewers. 1800 w. Eng News—March 9, 1905. No. 68272.

The Principles for the Determination of a Municipal Sewerage System (Die Grundlagen zur Berechnung von Städteentwasserungsanlagen). H. Heyd. A discussion of the fundamental principles for determining the amount of storm water and sewage to be carried off from a given locality. 3000 w. Gesundheits-Ingenieur —Jan. 20, 1905. No. 68703 D.

Subways.

Chicago's Freight Subways. An illustrated account of these subways showing the great advantage of the system. 1500 w. Sci Am—March 11, 1905. No. 68249.

The Construction of Section I, New York Rapid Transit R. R. Illustrates and describes the construction of the section between Chambers and Ann streets, including the City Hall loop and station, and the Brooklyn Bridge station, New York. 2000 w. Eng Rec—March 11, 1905. No. 68265.

WATER SUPPLY.

Cambridge, Mass.

Cambridge Water-Works. An illustrated article giving information of the plant and repairs of forty-inch steel main. 1600 w. Fire & Water—March 11, 1905. No. 68258.

Dam.

See Civil Engineering, Construction.

Electrolysis.

See Street and Electric Railways.

Filtration.

The Antietam Filters of the Reading Water Works. Illustrated detailed description of the second slow sand filter plant in this city. 1800 w. Eng Rec—March 25, 1905. No. 68627.

Fire Service.

Proposed High-Pressure Fire System for the Borough of Manhattan, New York. An abstract of the report of I. M. de Varona, proposing a system to protect the business area of New York. 4500 w. Eng News—March 23, 1905. No. 68587.

The Revised Plans for a Fire-Protection Water System for New York. Outlines the plans for protecting the so-called dry-goods district of the city as proposed by I. M. De Varona. 2000 w. Eng Rec —March 25, 1905. No. 68629.

Water Supply for Fire Service. Treats of the hydraulic phase of fire protection, as distinguished from the work of the chemical engine. 4800 w. Fire & Water—March 25, 1905. No. 68610.

Gravity Tunnel.

Gravity Tunnel for the New Water-Works of Cincinnati. J. A. Hiller. An illustrated detailed description of the construction. 3500 w. Eng Rec—March 4, 1905. No. 68180.

Irrigation.

A Great Irrigation Project in the Punjab. An illustrated account of a new project, estimated to cost about £5,200,000 for the construction of a great irrigation system. Map. 2700 w. Engr, Lond—Feb. 17, 1905. No. 68058 A.

Pumping System.

Coolgardie, Australia, Pumping System. An illustrated article giving an abbreviated history of the greatest pumping scheme ever carried out. 3000 w. Min & Sci Pr—Feb. 25, 1905. No. 68177.

Rainfall.

Maximum Rates of Rainfall at Boston. Continued discussion of paper by Charles W. Sherman. 4000 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68577 E.

Rand.

The Rand Water Board. An account of the movement to supply the Witwatersrand area with water for the growing demands of the inhabitants, industries and trades. 5000 w. Engr, Lond—March 17, 1905. No. 68663 A.

Regulating Valve.

An Automatic Regulating Valve for Reservoirs or Stand-Pipes Supplied from a Higher Elevation. J. W. Ledoux. Illustrated description of a device that has been tested and works with certainty. 900 w. Eng News—March 9, 1905. No. 68277.

Reservoirs.

The New Reservoir Dams at Solingen (Les Nouveaux Barrages-Réservoirs de Solingen). M. Jacquinot. A comparison of some recently constructed reservoir dams in Germany with similar structures in France. 2000 w. Génie Civil—Feb. 25, 1905. No. 68414 D.

Stave Pipes.

Stave Pipes for Conveying Water. Illustrations and description of the line of wood stave pipe of the Washington and Oregon Power Co., in Northeastern Oregon, in connection with their hydro-electric power plant. 1800 w. Min & Sci Pr—March 18, 1905. No. 68633.

Wood Stave Conduit. Kenneth Allen. Illustrates and describes the construction of the new conduit for Atlantic City water supply. 2200 w. Munic Jour & Engr—March, 1905. No. 68260 C.

Thawing.

Electrical Thawing of Water Pipes. From a report by George S. Haley for the Nat. Elec. Lgt. Assn. Describes the requisites and methods of procedure. 2800 w. Can Engr—March, 1905. No. 68243.

Wales.

Swansea Water Works. Illustrated description of works for increasing the water supply, consisting of a storage reservoir, tunnel, pipe-line, and service reservoir, explaining the interesting features. 2400 w. Engng—March 3, 1905. No. 68307 A.

Water Meters.

Accuracy Tests of Water Meters at Des Moines, Ia. Charles B. Burdick. Abstract of a paper read at meeting of the Illinois Soc. of Engrs. Reports the testing of 1,064 meters of various makes and sizes. 1500 w. Eng News—March 9, 1905. No. 68283.

Water Pipe.

Cost of Laying a 12-in. Water-Pipe Across a River. An account of how a 500-ft. line of 12-in. water pipe was laid and the cost. 700 w. Eng News—March 2, 1905. No. 68116.

West Africa.

Water Supply of West African Towns. Henry Reeve. Describes the protected tanks for holding rain-water, the construction of wells, and other means of supply suited to the location and conditions. 4500 w. Jour Roy San Inst—Jan., 1905. No. 68069 E.

WATERWAYS AND HARBORS.

Backwater.

The Maximum Absolute Height of Backwater behind a Weir (Das Absolute Maximum des Hydraulischen Staues). Dr. B. Tolman. Deriving formulas and a diagram for computing the height to which water is backed up at any given distance behind a dam or weir. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—March 3, 1905. No. 68461 D.

California.

Report of the Commission of Engineers on the Rectification of the Sacramento and San Joaquin Rivers. Describes work, to cost nearly 25 million dollars, for protecting some 1,700 sq. miles from floods. Map. 7500 w. Eng News—March 9, 1905. No. 68276.

Canada.

Harbor and River Works in Canada. Extracts from the report of A. Gobeil giving a general review of the works now under construction by the Government. 4400 w. Can Engr—March, 1905. No. 68242.

Canal Lift.

Inclined-Plane Canal Lifts (Ueber Schiffs-Förderung auf Schiefen Ebenen mit Längsneigung). Fr. Jebens. A discussion of canal lifts in which the boats are floated in tanks, the latter being drawn up on tracks on inclined planes. 1800 w. Glasers Annalen—March 15, 1905. No. 68457 D.

Cranes.

Shipyard Cranes and their Functions in Marine Construction. Jos. S. Shultz. A fully illustrated review of the principal types, showing their applications and performance as labor saving machines. 3500 w. Engineering Magazine—April, 1905. No. 68723 B.

Current Propulsion.

The Propulsion of Boats by the Current (Propulsion des Bateaux par le Courant). G. Laurent. Proposing a method of propelling boats in canals and other artificial waterways by the maintenance of a continuous current in the stream. 1800 w. Rev Technique—Feb. 25, 1905. No. 68427 D.

Dredging.

Sand-Pump Dredging on the Mersey. The present article is mainly an illustrated description of the latest sand-pump dredger, "Coronation," and its working. 4000 w. Engng—March 10, 1905. Serial. 1st part. No. 68538 A.

Dry Dock.

The Construction of the Charleston Dry Dock. An illustrated detailed description of difficult foundation work. 2400 w. Eng Rec—March 4, 1905. No. 68183.

Mississippi.

The Improvement of the Mississippi River Between St. Louis and Cairo. William P. Wooten. A paper published by the Engng. School, U. S. A., Washington Barracks, D. C. A summary of the work in progress by the U. S. Government, with interesting explanation of the natural causes that produce the conditions found in the beds of such rivers. 5200 w. Eng News—March 9, 1905. No. 68274.

Movable Dam.

The Beaver Movable Dam. W. H. Chadbourn, Jr. Illustrates and describes a movable dam in the Ohio River, about 31 miles from Pittsburg, which was opened in August, 1904. 3000 w. Eng Rec—March 11, 1905. No. 68269.

Panama.

Report of the Committee on Engineering of the Isthmian Canal Commission. Report of William H. Burr and William Barclay Parsons outlining the work of the Committee between Jan. 24 and Feb. 14. 5000 w. Eng News—March 2, 1905. No. 68120.

Report on, and Progress Views of, the Panama Canal. Gives interesting views of excavation on the Panama Canal, with some general information, and the report of the engineering committee of the Isthmian Canal Commission. 7000 w. Ry & Engng Rev—March 18, 1905. No. 68505.

Some Engineering Features of the Panama Canal. F. E. Turneaure. Gives a general description of the work, discussing the Bohio dam, the Culebra Cut, and other features. 3800 w. Wis Engr—March, 1905. No. 68603 D.

The Equipment of Engineers Going to Panama. Henry A. Harris. Valuable information from competent authority in regard to clothing needed, accommodations, cost of living, &c., and the general conditions to be found on the isthmus. 2300 w. Eng News—March 2, 1905. No. 68115.

The Panama Canal. The present article reviews the recent history of the project, explaining present conditions. 3500 w. Engr, Lond—March 3, 1905. Serial. 1st part. No. 68312 A.

Rhine.

The Technology of Waterway-Improvement, with Especial Reference to the Rhine (Technik und Wasserstrassenabgaben mit besondrer Beziehung auf den Rhein). Dr. J. Landgraf. A review of the improvements which have been made on various stretches of Rhine, with data as to costs. 3500 w. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68410 D.

Stream Gauging.

See Civil Engineering, Measurement.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The Conversion of a Telephone Exchange from the Magneto to the Central Battery System. B. S. Cohen. Describes the methods adopted in carrying out the conversion, with as little inconvenience as possible to the telephone public. 1500 w. Elec Rev, Lond—Feb 17, 1905. Serial. 1st part. No. [illegible] A.

Rectifier.

An Electrolytic Rectifier for Telephone Stations (Elektrolytischer Gleichrichter für Fernsprechanlagen). R. Stosberg. Illustrating an arrangement of electrolytic rectifier for converting three-phase into continuous current, for telephone service. 800 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68473 B.

Ship Telephones.

Telephones on the Great Northern Steamship Minnesota. A. F. Boardman. Illustrated detailed description of what is said to be the largest installation of a telephone system on shipboard. 1400 w. Marine Engng—March, 1905. No. 68107 C.

Space Telegraphy.

Interference in Wireless Telegraphy. John Stone Stone. Read before the Canadian Soc. of Civ. Engrs. Discusses interference due to static charges and interference due to electromagnetic waves. 4800 w. Elec Rev, N. Y.—March 25, 1905. No. 68607.

The Schloemilch Electrolytic Detector. A. Frederick Collins. Describes this instrument for use as a transmitter, with a telephone receiver for space telegraphy. 900 w. Elec Wld & Engr—March 11, 1905. No. 68284.

Wireless Telegraph Licences. Full text of the "Commercial" licence prepared by the British Postmaster-General in accordance with the terms of the Wireless Telegraph Act, 1904. Also editorial. 5700 w. Elect'n, Lond—March 17, 1905. No. 68652 A.

Telegraphy.

Setting Type by Telegraph. Donald Murray. Briefly considers the conditions to be fulfilled, and the work that has been done, especially describing the Murray automatic system. Ills. 13500 w. Inst of Elec Engrs—Feb. 23, 1905. No. 68379 D.

Telephone Lines.

Telephone Line Engineering. C. J. H. Woodbury. Explains methods of standard aërial and underground-line construction and methods of overcoming difficulties through mountains, over rivers, gorges and savannahs. 9500 w. Jour Fr Inst—March, 1905. No. 68343 D.

DISTRIBUTION.

Alternating Current.

The Variation of Power with Resistance in an Alternating-Current Circuit. E. P. Hollis. Brief account of an investigation showing that the maximum power is obtained in an alternating-current circuit when the resistance is equal to the reactance. 400 w. Elec Engr, Lond—March 10, 1905. No. 68524 A.

Cables.

The Selection of Electric Cables. L. B. Atkinson and C. J. Beaver. Read before the Manchester Sec. of the Inst. of Elec. Engrs. The present part deals with rubber insulated cables, the tests of materials, &c. Gives hints for the selection of cables. 3500 w. Elect'n, Lond—Feb. 17, 1904. Serial. 1st part. No. 68066 A.

Earthing.

"Earthing." W. W. Lackie. Abstract of a paper read at Glasgow, before the Inst. of Elec. Engrs. Criticises the regulations issued by the Inst. of Elec. Engrs. and emphasizes the necessity of insulating the sheathing throughout its length, earthing it at one point only, and introducing a proper sized resistance on the earth circuit. 3500 w. Elec Rev, Lond—Feb. 17, 1905. No. 68063 A.

Faults.

The Localization of Faults on Cables. Explains a method of localizing faults in light and power cables by use of a dynamo and motor; measuring the drop in pressure across the fault. 1200 w. Elec Rev, Lond—March 3, 1905. No. 68303 A.

Regulator.

A New Electromagnetic Contact Arrangement for Automatic Switches (Ueber eine Neue Elektromagnetische Kontaktvorrichtung für Selbsttätige Schaltwerke). Paul Thieme. Describing an improved form of automatic switch for maintaining a constant voltage between given points. 3000 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68472 B.

The Use of an Auxiliary Dynamo as a Battery Regulator (Verwendung von Zusatzmaschinen als Zellenschalter). B. Jacobi. Describing a convenient regulating system for a small electric station, using a storage battery. 2000 w. Elektrotech Zeitschr—March 9, 1905. No. 68477 B.

ELECTRO-CHEMISTRY.

Applied Chemistry.

Recent Examples of Applied Chemistry. James M. Camp. Address of the retiring president of the Engrs.' Soc. of W. Penn. Deals largely with applications made possible by electrochemistry. 3500 w. Pro Engrs' Soc of W Penn—Feb., 1905. No. 68089 D.

Calculations.

Metallurgical Calculations. J. W. Richards. The first article of a serial on this subject, giving the scope of the treatise and introductory remarks, and discussing the chemical equation, weights and volumes of gases, correction of gas volumes for temperature and pressure, with problems. 4000 w. Elec-Chem &

Met Ind—March, 1905. Serial. 1st part. No. 68151 C.

Card Index.

A System of Classification for an Electrochemical Bibliography. Adolph L. Volge. An explanation of a system on the decimal system for arranging a card index. 2400 w. Elec-Chem & Met Ind—March, 1905. No. 58152 C.

De-Tinning.

Methods of Removing the Tin from Tin-Plate Wastes (Fortschritte auf dem Gebiete der Entzinnung von Weissblechabfällen). Dr. H. Mennicke. A review of the development of electrolytic process for recovering the metallic tin from tinplate scrap. Serial. Part I. 2000 w. Elektrochem Zeitschr—Feb., 1905. No. 68487 G.

Dissociation.

The Theory of Electrolytic Dissociation (La Théorie de la Dissociation Electrolytique). Max Roloff. A review of recent studies in electrolytic dissociation, based upon the theory of ions. Serial. Part I. 3000 w. L'Electrochimie—Jan., 1905. No. 68489 D.

Electro-Metallurgy.

Electro-Production of Iron and Steel. Details from the report of the Canadian Commission, appointed to investigate the different electro-thermic processes for the smelting of iron ores and the making of steel. 2500 w. Engr, Lond—March 3, 1905. No. 68314 A.

Recent Developments in Electric Smelting in Connection with Iron and Steel. F. W. Harbord. Read before the Faraday Society. Mainly a résumé of the report of the Canadian Commission. 3800 w. Ir & Coal Trds Rev—March 10, 1905. No. 68549 A.

The Kjellin Process for the Electric Refining of Steel (Das Kjellinsche Verfahren zur Elektrischen Erzeugung von Stahl). V. Engelhardt. A description of the plant at Gysinge in Sweden, and data concerning the cost of the electric smelting of steel. Three articles. 5000 w. Stahl u Eisen—Feb. 1, 15, March 1, 1905. No. 68434 each D.

The Thermo-Chemistry of Iron Ore Reduction and Steel Making in the Electrical Furnace. Horace Allen. Discusses the limits necessitated by the chemical reactions. 2500 w. Cassier's Mag—March, 1905. No. 68125 B.

Solid Electrolytes.

Electrochemical Reactions in Solid Electrolytes. Prof. F. Haber and H. Tolloczko. Report of investigations, especially of the electrolysis of solid barium chloride at about 400° below its melting point. 2000 w. Elec-Chem & Met Ind—March, 1905. No. 68150 C.

Tantalum.

The Preparation and Properties of Tantalum (Das Tantal, seine Darstellung und seine Eigenschaften). Dr. Werner von Bolton. Describing fully the electrolytic method of producing pure tantalum for use in the tantalum incandescent lamp. 3000 w. Zeitschr f Elektrochemie—Jan. 20, 1905. No. 68485 D.

ELECTRO-PHYSICS.

Alloy.

Experiments upon the Heusler Ferromagnetic Alloy of Manganese, Aluminium, and Copper (Versuche mit Heuslerschen Ferromagnetischen Mangan-Aluminium-Kupfer Legierungen). E. Gumlich. A report of the tests made by the Reichsanstalt upon the magnetic properties of an alloy composed of non-magnetic metals. 5000 w. Elektrotech Zeitschr—March 2, 1905. No. 68475 B.

Dampers.

The Effect of Dampers on Harmonics (Sur les Etouffeurs d'Harmoniques). Maurice Leblanc. Discussing a method of inserting damping coils in alternators so as to suppress the harmonic irregularities in the alternations. 6000 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68491 F.

Dielectrics.

Report on Temperature Experiments Carried Out at the National Physical Laboratory. E. H. Rayner. Deals with investigations undertaken on behalf of the Engineering Standards Committee. The first part was on the effect of heat on the properties of insulating materials usually employed in electrical machinery; the second deals with the internal temperature of field coils of continuous-current machinery. 10400 w. Ill. Inst of Elec Engrs—March 9, 1905. No. 68639 D.

Eddy Currents.

Eddy-Current Losses in Massive Pole Shoes (Wirbelstromverluste in Massiven Polschuhen). Reinhold Rüdenberg. Deriving formulas for the computation of the losses due to eddy currents, based upon the oscillation theory. 3500 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68471 B.

Foucault Currents in the Armature Cores of Continuous-Current Dynamos (Sur les Courants de Foucault dans le Fer Induit des Machines à Courant Continu). R. V. Picou. A mathematical examination, showing that the losses from eddy currents are greater than has hitherto been admitted. 3000 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68490 F.

Electric Discharges.

The Ionic Theory of the Arc and Spark.

Prof. Henry Crew. Considers the two modes of ionization involved, and how nearly the electron theory explains the action. 8200 w. Jour W Soc of Engrs—Feb., 1905. No. 68093 D.

The Law of Electrical Discharges Through Air. Gives results of some interesting tests on the length of discharge path in air at high voltages as described by H. Grob in a recent article in the *Elektrotechnische Zeitschrift.* 1400 w. Elec Engr, Lond—Feb. 24, 1905. No. 68214 A.

Potential Differences.

Electric Potential and Sparking Distance in Air. Briefly examines recent work on high potential differences, with particular reference to the sparking distance in air. 2000 w. Engng—March 17, 1905. No. 68661 A.

Radio-Activity.

Radium and Radio-Activity in General. Robert H. Bradbury. The atomic theory; radium rays; the radio-active process in comparison with ordinary chemical changes, &c. 4000 w. Jour Fr Inst—March, 1905. No. 68347 D.

Solenoids.

Predetermination of Solenoid Characteristics. Paul C. Percy. Describes method of getting approximate dimensions and excitation for designing a stopped solenoid, giving tables for use, and illustrating their application by examples. 1200 w. Am Elect'n—March, 1905. No. 68141.

Transformers.

A Note on Transformers (Sur les Transformateurs). E. Brylinski. A mathematical discussion of the phenomena of resonance as exhibited in the operation of transformers. 3500 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68492 F.

GENERATING STATIONS.

Alternators.

Expressions for the Power Delivered by Two Alternators in Parallel (Expression des Puissances Fourmés par Deux Alternateurs en Parallele). C. F. Guilbert. Developing graphical methods for determining the relative and joint performances of the two machines. Two articles. 4000 w. Rev Technique—Feb. 10, 25, 1905. No. 68424 each D.

Parallel Operation of Dynamos Having Different Characteristics. Lamar Lyndon. Considers a case of paralleling several generators having different characteristics, explaining facts necessary to a clear understanding. Diagrams. 2000 w. Am Elect'n—March, 1905. No. 68143.

Parallel Running of Alternators Driven by Large Gas Engines. E. Kilburn Scott. Considers there is no difficulty whatever in running three-phase generators in parallel when driven by large gas engines, and calls attention to some points to be remembered. 1000 w. Elec Rev, Lond—March 10, 1905. No. 68527 A.

The Erection of 5,000-KW. Engine-Driven Alternators. R. L. Wilson. Illustrates and describes the installation of the generators which furnish power for the operation of the trains in the New York Subway. 3800 w. Eng News—March 23, 1905. No. 68584.

Bridlington.

Bridlington Electricity Works. An illustrated article giving the history of this undertaking in England, with description of the works and their equipment. 3300 w. Elec Engr, Lond—March 3, 1905. No. 68301 A.

Dynamos.

Acyclic (Homopolar) Dynamos. Discussions at New York and Boston of paper by J. E. Noeggerath. 4,000 w. Am Inst of Elec Engrs—March, 1905. No. 68560.

Electrical Machinery.

Diseases of Electrical Machinery. F. B. Crocker and S. S. Wheeler. A statement of troubles with their symptoms and remedies, prepared to facilitate their detection and elimination. Ills. 4800 w. Am Elect'n—March, 1905. No. 68144.

Electrical Plant.

The Frodingham Iron and Steel Company's New Electrical Plant. An illustrated description of an interesting power and lighting plant. 2000 w. Ir & Coal Trds Rev—March 3, 1905. No. 68317 A.

Hydro-Electric.

An Important Italian Hydro-electric Installation. Enrico Bignami. Brief illustrated description of a new water-power station planned by Italian engineers and equipped entirely with Italian machinery, at Zogno, Italy. 800 w. Elec Rev, N Y—March 11, 1905. No. 68288.

Interesting Power Plant at Olympia, Washington. Illustrated description of a new and thoroughly modern water-power plant. 1500 w. St Ry Jour—March 11, 1905. No. 68261 C.

Large Norwegian Power Installation. Brief description of the Kykkelsrud power installation, comprising a water-power of 45,000 effective horse-power. 1000 w. Engng—March 10, 1905. No. 68540 A.

The Cellina Hydro-Electric Plant (L'Impianto Idroeléttrico del Cellina). A full description of the plant at Cellina near Pordenone, in Northern Italy, deriving 2600 horse-power from the Cellina. Two articles, 4000 w. L'Elettricita—Feb. 10, 24, 1905. No. 68715 each B.

The Gromo Hydro-Electric Plant. (Nuovo Impianto Idro-Elettrico di Gromo). Illustrating and describing a plant deriving 2000 horse-power from the Serio, at Gromo, in Northern Italy. 3000 w. Il Monitore Tecnico—Jan. 30, 1905. No. 68710 D.

The Hydraulic Power of Lakes Joux and Orbe (Les Forces Motrices des Lacs de Joux et de l'Orbe). C. H. Perrin. A description of the power stations at La Dernier and Montcherand deriving 6000 to 8000 horse-power each from the mountain streams above the Lake of Geneva. Two articles, 6000 w., 1 plate. Génie Civil —Feb. 25, March 4, 1905. No. 68413 each D.

The Japanese Hydro-Electric Power Plant at Kyoto and Lake Biwa Canal Development. Frank C. Perkins. Illustrations and drawings showing the present hydro-electric power development of the Lake Biwa canal, describing this and the proposed new waterway of much larger capacity. 2000 w. Sci Am Sup—March 18, 1905. No. 68330.

See also Mechanical Engineering, Hydraulics.

Isolated Plant.

Power and Lighting Equipment of a Brooklyn Museum. E. T. Walsh. Illustrates and describes the plant of the Brooklyn Inst. of Arts and Sciences. 2500 w. Am Elect'n—March, 1905. No. 68139.

Some Notes on the Running of a Private Lighting and Power Plant. P. T. Blisset. Read before the Dublin Loc. Sec. of the Inst. of Elec. Engrs. Descriptive notes of a large private three-wire light and power plant, showing how electrical driving has gradually superseded steam driving and gas lighting. 2500 w. Elec Eng, Lond—Feb. 24, 1905. Serial. 1st part. No. 68213 A.

Power House.

Construction of the Port Morris Power House for the New York Central R. R. Brief description of methods of constructing the foundations for a 30,000 k.w. power house. Ills. 1800 w. Eng Rec—March 4, 1905. No. 68186.

Power House of the Indianapolis & Cincinnati Traction Company. Illustrated detailed description of the power station at Rushville, Ind., and its equipment. 3500 w. St Ry Jour—March 18, 1905. No. 68392 C.

Station Troubles.

An Unusual Power Station Trouble. L. H. Pike. Gives an account with diagrams, of an actual occurrence, and the method of remedying it. 2500 w. Power—March, 1905. No. 68171 C.

Switchboards.

An Ideal Switchboard Base. Leonard J. Pumphrey. Gives results of experiments made on marble, slate and opaline switchboards, showing the superiority of the last named material. 1200 w. Elec Rev, Lond—Feb. 24, 1905. No. 68217 A.

Switchgear.

Switchgear for the Fisher Street Substation of the Metropolitan Electric Supply Company, Limited, London. Illustrates and describes the unique features of this gear, such as the remote control from one platform, the protected extra high tension connections, the depressor method of starting, etc. 3000 w. Elec Engr, Lond —Feb. 24, 1905. No. 68211 A.

Switzerland.

The Municipal Electric Station at Winterthur (Das Stadtische Elektrizitätswerk in Winterthur). S. Herzog. Illustrating and describing especially the transformer station and rotaryconverter plant. 1800 w. Zeitschr f Elektrotechnik —March 12, 1905. No. 68484 D.

Tariffs.

Methods of Charging for Electric Current (Ueber einige Stromtariffragen). Dr. Gotthold Stern. A discussion of the various methods of determining the price to be charged the customer for electric current supply. 3000 w. Zeitschr f Elektrotechnik—Feb. 19, 1905. No. 68479 D.

The Charges for Municipal Electric Lighting Plants (Städische Lichtwerke und deren Besteuerung). Paul Hecht. Giving data of operating costs, and discussing the best method of distributing charges. 1800 w. Zeitschr f Elektrotechnik—Feb. 26, 1905. No. 68481 D.

Taunton, Mass.

The Largest Municipal Plant in New England. Alan D. Adams. Illustrated description of the new plant at Taunton, Mass. 2500 w. Elec Rev, N Y—March 4, 1905. No. 68128.

Transformers.

Oil-Insulated Versus Air-Blast Transformers. M. A. Sammett. Gives practical results aiming to show the superiority of the oil-insulated type. 2500 w. Elec Rev, N Y—March 18, 1905. No. 68394.

LIGHTING.

Mercury Vapor.

Physiological Effects of the Mercury-Vapor Lamp (Physiologische Betractungen über die Wirkungen von Quecksilberdampflampen). Dr. E. Schiff. Discussing especially the action of the emitted violet rays upon the human skin. 1200 w. Zeitschr f Elektrotechnik—March 5, 1905. No. 68483 D.

Progress with the Mercury-Vapor Lamp (Fortschritte bei Quecksilberdampflampen). S. Strauss. Describing recent developments with the Cooper-Hewitt lamp in Europe and America. 3000 w. Zeitschr f Elektrotechnik—March 5, 1905. No. 68482 D.

Nernst.

The Nernst Lamp (Die Nernst-lampe). Dr. Ernst Salomon. An address before the Electrotechnical Society of Vienna, reviewing the development of the Nernst lamp in Germany. 3000 w. Zeitschr f Elektrotechnik—Feb. 26, 1905. No. 68480 D.

Osmium.

The Osmium Incandescent Electric Lamp (Die Elektrische Osmium Glühlample). Fritz Blau. A paper before the Berlin Electrotechnical Society, giving data as to the life and illuminating power of the Welsbach osmium lamp. 4000 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68474 B.

Portable Plant.

English Fire Engine Portable Electric Light Operated with Liquid Fuel. Frank C. Perkins. Illustrations and drawings showing the details of construction and method of operating a new English portable electric light plant for fire department service. 500 w. Elec, N Y—March 1, 1905. No. 68085.

School Lighting.

The Lighting of School Rooms (Ueber die Beleuchitung von Schulräumen). Prof. Ludw. Stelz. Data and results of tests of the distribution of light from incandescent electric lamps in the rooms of the Göthe gymnasium in Frankfort. 2500 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68467 B.

Tantalum Lamps.

Some Tests of Tantalum Lamps. A. E. Kennelly and S. E. Whiting. An account of some interesting tests made in the laboratory of Harvard University. 1200 w. Elec Wld & Engr—March 25, 1905. No. 68636.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

Amperemeter.

An Amperemeter for High Potential Currents. H. Clyde Strook. Describes an instrument for measuring currents flowing in the secondary circuits of induction coils. It is especially adapted for use in X-ray work. 2000 w. Jour Fr Inst—March, 1905. No. 68344 D.

The Application of the Carpentier Thermic Amperemeter to the Determination of Power Factors (Application de l'Ampèremètre Thermique J. Carpentier à la Mesure des Puissances et des Decalages). L. Joly. Showing how the Carpentier amperemeter replaces the voltmeter, amperemeter and wattmeter. 3500 w. Bull Soc Int d Electriciens—Feb., 1905. No. 68494 F.

Harmonic Analysis.

Harmonic Analyzer. George H. Rowe. Describes a particular form of analyzer designed to be accurate and inexpensive and of sufficient range for all practical purposes. Also editorial. 2500 w. Elec Wld & Engr—March 25, 1905. No. 68635.

Instruments.

Instruments of Precision and a New Type of Portable Instruments. J. Brown. Describing the Westinghouse integrating wattmeter, portable ammeter, and power-factor meter, with data concerning calibrating and testing. 3300 w. Wis Engr—March, 1905. No. 68602 D.

Lightning Recorder.

A Simple, Effective, and Inexpensive Lightning Recorder. Henry F. Alciatore. Illustrated description of a lightning recorder designed to obtain automatic records of the hundreds of electric discharges, visible and invisible, that usually precede and accompany thunder-storms. 1800 w. Sci Am Sup—March 18, 1905. No. 68333.

Meters.

Polyphase Meters. Deals only with watt-hour-meters and the theory underlying them. 1200 w. Elec Rev, Lond—March 10, 1905. No. 68526 A.

Oscillograph.

Notes on Some Effects on Three-Phase Working. W. M. Thornton. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. Gives results of investigations with the oscillograph undertaken for the purpose of deciding questions of importance in the regular working of the plant. 3000 w. Elec Engr, London—March 10, 17, 1905. Serial, 2 parts. No. 68647 each A.

Oscillograph Investigations by the Central Laboratory of Electricity (Recherches Oscillographes Effectuées par la Laboratoire Central d'Electricité). Ch. David. An account of experiments conducted on the high tension lines of the company "Energie Electrique du Littoral Mediterranean." 10,000 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68493 F.

Potentiometer.

The Potentiometer. W. M. Nelson. Read before the Queensland Elec. Assn. Briefly describes the instrument and discusses its possibilities for general testing and measurement of electromotive force. 3500 w. Aust Min Stand—Feb. 9, 1905. No. 68553 B.

Rating.

Temperature Curves and the Rating of Electrical Machinery. Rud. Goldschmidt. Discusses short-time rating; the temperature curve; heating and cooling; crane rating, etc., giving methods and examples. 7500 w. Inst of Elec Engrs—March 9, 1905. No. 68646 D.

Testing.

Instrument Equipment of a Testing Department. F. Conrad. Read before the Ohio Elec. Lgt. Assn. Considers portable testing instruments, auxiliary devices, and standard instruments. 3300 w. Cent Sta —March, 1905. No. 68285.

Voltameters.

Mercury Voltameters (Ueber Quecksilbervoltameter). H. Danneel. Describing various forms of mercury voltameter, showing how they may be employed as electric meters. 2000 w. Zeitschr f Elektrochemie—March 10, 1905. No. 68486 D.

MOTORS.

Induction Motors.

A Practical Vector-Diagram for Induction Motors. H. C. Specht. An explanation of a vector diagram method for analyzing the behavior of induction motors which is applicable to single-phase as well as polyphase induction motors of all sizes. 4000 w. Elec Wld & Engr—Feb. 25, 1905. No. 68081.

The Computation of the Stray Co-efficient of Induction Motors (Berechnung des Streuungskoffizienten bei Drehstrommotoren). Karl Pichelmayer. Deriving formulas for practical use, with tabulated results of its application to a number of machines. 2500 w. Zeitschr f Elektrotechnik—Feb. 12, 1905. No. 68478 D.

Machine Driving.

See Mechanical Engineering, Power and Transmission.

Railway Motors.

The Alternating-Current Series Motor. F. D. Newbury. An illustrated article explaining the advantages of the neutralizing field winding. 900 w. Elec Club Jour—March, 1905. No. 68507.

TRANSMISSION.

Efficiency.

Electrical Transmission. G. W. Worrall. Read before the Liverpool Univ. Engng. Soc. Discusses efficiency of transmission, the form of current best adapted, high tension transmission, inductance and capacity, with brief description of the system of M. Thury, a Swiss engineer. 2800 w. Elec. Engr, Lond—March 17, 1905. No. 68648 A.

High Tension.

The First European Transmission at 40,000 Volts from Gromo to Nembro (La Prima Trasmissione Europea a 40,000 Volt tra Gromo e Nembro). Describing the new line over which the 2000 horsepower of the Gromo station is delivered to Nembro, a distance of 32 kilometres. Two articles, 3500 w. L'Elettricita—Jan. 20, 27, 1905. No. 68714 each B.

Insulators.

High-Tension Insulators. E. H. Craffer. An illustrated article considering insulators for high-pressure wires, the requirements, etc. 2500 w. Engng—March 17, 1905. Serial. 1st part. No. 68657 A.

Oil for Insulating Purposes. Abstracted from a pamphlet published by the Westinghouse Elec. & Mfg. Co., of Pittsburg, written by C. E. Skinner. On methods of testing, and the quality of oil for transformer and oil-switch work. 2500 w. Elec Rev, N Y—March 18, 1905. No. 68395.

INDUSTRIAL ECONOMY

Cost Keeping.

The Cost System of an Engineering Works. H. Deighton. Detailed description of a successful working system, including cost keeping, stock tracing, stores control, and general accounting. 4500 w. Engineering Magazine—April, 1905. No. 68722 B.

Electric Transmission.

Economics of Transmission Problems. F. A. C. Perrine. Abstract of a lecture delivered before the Brooklyn, N. Y., Poly. Inst. Considers electric transmission a problem of economics rather than of engineering. 1500 w. Elec Rev, N. Y. —March 4, 1905. No. 68130.

Some Economic Aspects of Electric Power Distribution. Dr. Louis Bell. A discussion of the important influence of electric power distribution in redistributing industry and population. 3500 w. Engineering Magazine—April, 1905. No. 68710 B.

Office Work.

New Methods of Office Work. LeRoy Scott. Describes the many kinds of work now performed rapidly by ingenious machines, which formerly required much time and many hands. 3000 w. World's Work—March, 1905. No. 68164 C.

Order Craziness.

An editorial pointing out the poor business policy of permitting salesmen, through eagerness for orders, to urge the purchase of mechanical equipment actually unsuited to the needs of customers. 600 w. Air Power—April, 1905. No. 68718.

Patent Laws.

Patent Law with Reference to Engineering. C. A. Brown. Considers patentable inventions; the rights of the engineer and his client or employer with reference to inventions made by an engineer during his employment; and the function of the patent expert. 7300 w. Wis Engr —March. 1905. No. 68604 D.

Peat.

The Industrial Utilization of Peat for the Manufacture of Fibrous Packing (Die Technische Verwertung von Torfmooren zur Torfstreufabrikation). Bruno Simmersbach. Illustrating and describing a plant for the conversion of peat into a fibrous material for covering steam pipes, packing fragile articles, etc. 3000 w. Glasers Annalen—March 1, 1905. No. 68454 D.

Sanitary Betterment.

Sanitary Betterment in Large Industrial Plants. Severance Burrage. Considers the factors that have brought about the movement for improving these conditions, and gives illustrated descriptions of arrangements at various works. General discussion. 6500 w. Jour W Soc of Engrs—Feb., 1905. No. 68092 D.

Specialization.

Specialization in Manufacture. Abstract of a paper by Alexander E. Outerbridge, Jr., from *Annals of the Am. Acad. of Pol. & Soc. Sci.* Gives illustrations showing the advantages of specialization, the decrease of cost and increase of production. 1500 w. Am Mach—Vol. 28, No. 9. No. 68102.

Steel Corporation.

The United States Steel Corporation. Abstract of the third annual report. 3500 w. Ir Age—March 23, 1905. No. 68556.

Technology.

A Ministry of Technical Work (Das Ministerium der Technisch Arbeit). Max v. Kraft. A discussion of the importance of system in technical work, and the desirability of making it the subject of an official department. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—March 3, 1905. No. 68460 D.

Wage System.

The Question of Wages and Rewards (Preisbewegungen und Lohnfragen). R. Gundel. A review of various methods of remunerating labor, with especial reference to the various modifications of the Halsey premium system. 3500 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68470 B.

MARINE AND NAVAL ENGINEERING

Coaling.

Coaling of Ships of War at Sea and in Harbor. G. C. Mackrow. Illustrated description of a proposed system worked out at the Thames Ironworks. Describes the loading at sea and also in harbor. General discussion. 6300 w. Jour Roy U Serv Inst—Feb. 15, 1905. No. 68068 E.

Cruiser.

The French Armored Cruiser. Ernest Renan. Illustration, with brief description, and comparative table. 500 w. Engr, Lond—March 3, 1905. No. 68316 A.

The U. S. S. Chattanooga. W. W. White. General description of the vessel and its equipment, with report of standardization and official trials. 3000 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68516 H.

Current Propulsion.

See Civil Engineering, Waterways and Harbors.

Docks.

Floating - Dock Design (Ueber Schwimmdock Anlagen). Alexander Dietzius. With sections and data of a number of executed examples by various German firms, and diagrams and curves of stability. 4000 w. 1 plate. Schiffbau —Feb. 22, 1905. No. 68701 D.

Ferryboats.

New Ferryboats for San Francisco Harbor. Illustrates and describes boats capable of a maximum speed of 17 miles per hour, and of a high power of acceleration for a 15 minute service between San Francisco and Oakland. 1000 w. Marine Engng—March, 1905. No. 68106 C.

Fireboat.

Portland's New Fireboat. George H. Williams. Illustrated description of an interesting fire tug. 1600 w. Naut Gaz—March 23, 1905. No. 68606.

Gyroscopic Horizon.

Admiral Fleuriais's Gyroscopic Horizon. An illustrated description of an improved instrument likely to render important service at sea. 1100 w. Engng —March 17, 1905. No. 68662 A.

Lake Vessels.

The 10,000-Ton Lake Vessels. An illustrated article on the three series of 10,000-ton vessels under construction, which present new and widely different features from any that have been previously built. 1000 w. Ir Age—March 16, 1905. No. 68320.

Launching.

Launch of the James C. Wallace. An account of the launch, with illustrated description of the vessel and its construction. 3000 w. Marine Rev—March 16, 1905. No. 68385.

The Influence of Launching Stresses upon Vessels (Einfluss der Stampfbewegungen beim Stapellauf auf die Beanspruchung des Schiffes). Alexander Dietzius. A discussion of the action of the dynamic forces at the time of launching, and the manner in which they cause stresses upon the hull. 3000 w. Schiffbau —Jan. 11, 1905. No. 68700 D.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Motor Boats.

Engine Details of New Auto Boats Entered for Monaco (Mediterranean) Races. René M. Petard. Illustrations, with descriptions of special engines. 2000 w. Automobile—March 25, 1905. No. 68617.

French Auto Boats and Motors. Brief descriptions, with illustrations, of recent models shown at the Paris show. 2200 w. Automobile—Feb. 25, 1905. No. 68071.

Motor Boat Engines at the Sportsmen's Show. Illustrated descriptions of several noteworthy engines exhibited. 1400 w. Sci Am—March 4, 1905. No. 68122.

Napier II.—The Yarrow-Napier Racing Launch. Illustrated description of a rebuilt English boat which is to take part in the British International Cup Race, and in other events. 1600 w. Auto Jour—March 11, 1905. No. 68519 A.

Oil-Carrying.

The Oil-Carrying Fleets of the World J. D. Henry. Illustrates, describes and compares various types of bulk oil steamers and coal oil sailers showing the extent of this industry. 6000 w. Naut Gaz —March 2, 1905. No. 68156.

Progress.

Epochs in Marine Engineering. George W. Melville. Address delivered before the A. S. M. E. on Jan. 31, 1905. Considers the various periods with reference to the special inventions or changes which have characterized them; as the paddle wheel, the screw propeller, surface condensers, cylindrical boilers, compound engine, &c. 5400 w. Marine Engng—March, 1905. No. 68108 C.

Propellers.

Contract Trials of Ships as Experiments Upon Propellers. John Lowe. Showing that the data given furnish complete experiments upon the screw propeller of great value. 1400 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68513 H.

The Screw Propeller. R. de Villamil. The present article reviews the explanations that have been offered to explain how the screw propeller derives its thrust, and in a second article aims to show there is no solid foundation of truth in them. 3500 w. Engr, Lond—March 3, 1905. Serial. 1st part. No. 68311 A.

Repairs.

Story of the Operations of the Russian Fleet at Pt. Arthur as Told by One of the Commanders. Facts obtained in an interview with Capt. N. O. von Essen, who was in command of the battleship "Sevastopol," explaining a method of making repairs by means of caissons. Ills. 3500 w. Sci Am—March 11, 1905. No. 68250.

Resistance.

I. The Relation of Depth of Water to Speed and Power of Ships. An account of the German torpedo vessel experiments. II. A General Discussion of Resistance and Power Consumption of Ships in Different Depths of Water. D. W. Taylor. Suggested by the I. article. 5000 w. Eng News—March 16, 1905. No. 68338.

Sails.

The Design and Making of Sails. Adrian Wilson. Read before the Mass. Inst. of Tech. Briefly considers the proper distribution of the areas of the drawing power, method of finding the center of effort, different conditions under which a boat may be used, the shape and proportion of sails, &c. Ills. 5400 w. Marine Engng—March, 1905. No. 68105 C.

Scouts.

Scouts. Gives comparative data of some typical cruisers intended for scouting purposes, with information concerning this type of vessel, and remarks on its value as a warship. 1500 w. Engr, Lond —March 17, 1905. No. 68665 A.

Ship Telephones.

See Electrical Engineering, Communication.

Shipyards.

Application of Electricity to Industrial Purposes. J. F. C. Snell. Abstract of a paper read before the N.-E. Coast Inst. of Engrs. & Shipbuilders. Gives results and particulars in regard to the application of electricity to shipyards. 3000 w. Elect'n, Lond—March 3, 1905. No. 68305 A.

Stability.

The Gyration of Ships (Sur la Giration des Navires). E. Bertin. A study of the forces tending to capsize a vessel, and the statical moments by which they are resisted. 2000 w. Comptes Rendus—Feb. 6, 1905. No. 68417 D.

Steamships.

Cargo and Intermediate Steamers. From a paper by Edwin W. De Russett, in the Pro. of the Inst. of Civ. Engrs., London. Considers recent developments in Great Britain in building these two types of steamships. 2400 w. R R Gaz—Vol. XXXVIII., No. 9. No. 68147.

Strength.

The Transverse Strength of Ships (Querfestigkeit von Schiffen). J. Bruhn. An elaborate, and fully illustrated discussion of the transverse stresses acting upon the hulls of vessels and the principles of structural design involved. 5 articles. 5000 w. Schiffbau—Nov. 23, Dec. 14, 1904, Jan. 11, 25, Feb. 22, 1905. No. 68699 each D.

Methods of Estimating the Strength of Ships. Dr. J. Bruhn. Discusses methods of making strength calculations. 12400 w. Trans Inst of Engrs & Shipbuilders of Scot—Feb. 21, 1905. No. 68687 D.

Trials.

Cunard Liner Caronia. Illustrated description of this Cunard liner, her engines and her speed trials. 1400 w. Marine Rev—March 2, 1905. No. 68202.

Steam Trials of H. M. S. "Carnarvon." An illustrated description of this armored cruiser and report of the satisfactory results of the steam trials. 3500 w. Engng—March 17, 1905. No. 68658 A.

The U. S. S. Pennsylvania. Lewis Hobart Kinney. Illustrated detailed description of the vessel and its equipment, with report of trial. 8500 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68512 H.

United States Armored Cruisers West Virginia and Maryland. W. Strother Smith. Illustrated description of vessels with report of official trials. 7500 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68514 H.

Vibrations.

Apparatus for Recording the Vibrations of Steamers. An illustrated description of Schlick's recording apparatus for steamship vibrations, called a pallograph. 1200 w. Engng—March 3, 1905. No. 68308 A.

Weight.

The Weight of Ships (Il Peso delle Navi). Edwin Cerio. An examination of the computation and distribution of weights in a vessel, including hull, machinery, fuel, armament, etc. 6000 w. 2 plates. Rivista Marittima—Feb., 1905. No. 68698 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Body Building.

Artistic Body Building Methods. An illustrated article describing methods of designing and finishing in a Chicago carriage-building factory. 2500 w. Automobile—Feb. 25, 1905. No. 68073.

Charging Accumulators.

A New Method of Charging Accumulators. Illustrates and describes a small portable dynamo arranged on a base plate, together with the volt and ammeter. It is driven by means of a friction wheel rotated by one of the rear wheels of the car. 900 w. Autocar—March 11, 1905. No. 68550 A.

Clement-Talbot.

The 8 H. P. and 12 H. P. Clement-Talbot Cars. An illustrated detailed description. 1700 w. Autocar—March 18, 1905. Serial. 1st part. No. 68645 A.

Clutch.

The Bradley Multiple-Disc Clutch. Illustrates and describes the improved friction-clutch invented by E. F. Bradley. 2000 w. Auto Jour—March 11, 1905. Serial. 1st part. No. 68520 A.

Differential.

The Action of the Differential Gear of Automobiles (Sur le Mode de Frictionnement du Differential des Automobiles). A. Petot. A mathematical examination of the dynamic of differential transmission gears. 1000 w. Comptes Rendus—Feb. 20, 1905. No. 68420 D.

Electric Vehicles.

Electricity at the Berlin Automobile Exposition (Die Elektricität auf der Internationalen Automobilausstellung in Berlin). C. v. Groddeck. A general description of the exhibits, with especial reference to the accumulator electric automobiles. 2500 w. Elektrotech Zeitschr—March 2, 1905. No. 68476 B.

Exhibitions.

New Cars at the Boston Show. Brief illustrated descriptions of some of the new cars shown. 3000 w. Automobile—March 18, 1905. No. 68386.

The International Automobile Exhibition in Berlin (Die Internationale Automobil-Ausstellung in Berlin). F. Pflug. A general description of the various machines exhibited. Serial. Part I. 2500 w. Glasers Annalen—March 1, 1905. No. 68455 D.

Fire Engines.

Automobiles and Fire Fighting (La Lutte contre les Incendies et l'Automobilisme). Daniel Bellet. Describing various forms of automobile fire engines, and their success in actual fire service. 3000 w. Rev Technique—Feb. 10, 1905. No. 68422 D.

"Flash" Boilers.

"Flash" Boilers for Steam-Cars. J. S. V. Bickford. An account of an extensive series of experiments on boilers for auto cars. 3300 w. Engng—March 10, 1905. No. 68539 A.

Gasoline Cars.

General Suggestions for the Operation of Gasoline Runabouts or Touring Cars. A. D. River. Aims to indicate the principles underlying all gasoline machines, and the general method of procedure in their management. 8500 w. Automobile—March 11, 1905. Serial. 1st part. No. 68253.

Union Pacific Gasoline Motor Car. Illustration, with brief description, of a car for high-speed interurban and branch service to be used experimentally for local passenger service at Portland, Ore. 700 w. Ry Age—March 10, 1905. No. 68257.

Gobron-Brillie.

The 1905 Gobron-Brillie Petrol Cars. Illustrated description. 1400 w. Auto Jour—March 4, 1905. No. 68299 A.

Industrial Vehicles.

The Thornycroft Lurries, Omnibuses, and Vans. The present article illustrates a new 24 h.p. double deck petrol omnibus for 34 passengers, and begins a description of the commercial vehicles of this company. 700 w. Auto Jour—March 18, 1905. Serial. 1st part. No. 68644 A.

The Wolseley Industrial Vehicles. Begins an illustrated description of commercial vehicles fitted with internal-combustion engines. 700 w. Auto Jour—March 18, 1905. Serial. 1st part. No. 68643 A.

Mercedes.

American Mercedes Automobiles. An illustrated article giving information concerning these cars and their manufacture. 1800 w. Automobile—March 11, 1905. No. 68255.

Omnibuses.

Motor 'Buses vs. Electric Tramways. J. Clifton Robinson. Discusses this question as affecting England. Thinks the omnibus will find its usefulness as a "feeder" to other lines, but in no danger of supplanting the tramway. 2500 w. St Ry Rev—March 15, 1905. No. 68613 C.

Tramways v. Motor 'Buses. Henry M. Sayers. Discusses the commercial aspects, comparing costs and carrying capacities. 2000 w. Elect'n, Lond—Feb. 17, 1905. No. 68065 A.

Types of Motor Omnibuses at the Olympia Exhibition. Descriptions, with illustrations, of various makes of motor omnibuses now on the market. 5700 w. Tram & Ry Wld—March 9, 1905. No. 68528 B.

Racing Car.

Gordon-Bennett Racers for 1905. Mr. J. Hargreaves' 80-H. P. Napier. Illustrated description of the first of the new Napier racing cars for 1905. 600 w. Auto Jour—March 18, 1905. No. 68642 A.

Review.

The Progress of Automobilism in 1904 (Les Progrès de l'Automobilism en 1904). F. Drouin. Discussing especially the lessons of the various trials and races of the year on the Continent. 1800 w. Génie Civil—Feb. 25, 1904. No. 68415 D.

Sprinkler.

Automobile Steam Sprinkling Wagon (Tonneau d'Arrosage Automobile à Vapeur). E. Bret. Illustrating a large steam sprinkler used with salt water in the streets of Paris. 2000 w. Génie Civil—March 11, 1905. No. 68447 D.

Steam Cars.

A New Steam Motor Wagon. Illustrated detailed description of a five-ton steam motor wagon made in England. 700 w. Engr, Lond—March 17, 1905. No. 68667 A.

Steam Cars at the Boston Show. H. F. Donaldson. Descriptions and photographs of types displayed. 7500 w. Automobile—March 25, 1905. No. 68616.

Swift.

The Swift Petrol Cars. Illustrates and describes the two new types of vehicle being introduced by the Swift Company. 500 w. Auto Jour—Feb. 25, 1905. Serial. 1st part. No. 68207 A.

Trucks.

Foreign Automobile Trucks. Emile Guarini. Illustrated descriptions of some of the trucks exhibited at the Belgian Automobile Exhibition in Brussels. 1500 w. Sci Am Sup—March 25, 1905. No. 68601.

Packard 3,000-Pound Truck. Illustrates and describes a gasoline truck. 1000 w. Automobile—March 18, 1905. No. 68387.

Wheels.

Elastic Wheels. Considers the principles of action of elastic wheels intended to carry heavy loads on common roads. Does not consider wheels for motor cars and cycles. Ills. 3000 w. Engr, Lond—March 10, 1905. Serial. 1st part. No. 68544 A.

COMBUSTION MOTORS.

Carbureting.

The Carbureting of Heavy Oils. R. Desmarest. Translated from *L'Automobile*. States general laws evolved from a study of carburation, examining them successively from the point of view of their application to kerosene. 3800 w. Sci Am Sup—March 18, 1905. No. 68331.

Furnace Gas.

Commercial Possibilities of Blast Furnace Gas for the Development of Electric Power. F. du P. Thomson. Presents the advantages and disadvantages of the blast furnace gas power plant, giving details of estimated cost based on experience. Ills. 4800 w. Elec-Chem & Met Ind—March, 1905. No. 68149 C.

The Use of Coke Oven Gas in Gas Engines. An illustrated article explaining the operation of the by-product oven, the coking, the power available, its adaptability for use in engines, &c. 4500 w. Power—March, 1905. No. 68166 C.

The Use of Waste Gases in Large Gas Engines. Max Rotter. Read before the Illinois Steel Works Scientific Club. Considers the direct use of waste gases from coke ovens and blast furnaces in large gas engines. 3500 w. Ir Age—March 16, 1905. No. 68321.

Gas Engines.

Gas Blowing Engines. T. Westgarth. Gives 15 figures, with brief descriptions, and charts showing the running. 2400 w. Jour W of Scot Ir & Steel Inst—Feb., 1905. No. 68691 F.

Large Gas Engines (Gross-Gasmaschinen). A. Riedler. An exhaustive review of the development of the large gas engine, with details of construction of leading types, and a review of performance and efficiency; an important paper. 20,000 w. Zeitschr d Ver Deutscher Ing—Feb. 25, 1905. No. 68403 D.

Test of a 500 h. p. Gas Engine Using Coke-Oven Gas (Bericht über Leistungsversuche an einer 500 pferdigen Koksofengasmaschine). Dr. Eugen Meyer. Data and results of tests of an Oechelhaeuser engine, originally designed for blast-furnace gas, and altered for coke-oven gas. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 25, 1905. No. 68404 D.

The Computation of the Efficiency and Capacity of Gas Engines (Die Berechnung des Mechanischen Wirkungsgrades und der Leistung von Gasmaschinen). A. Riedler. A discussion of the correct method of computing the mechanical efficiency of a gas engine. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 25, 1905. No. 68405 D.

The Strang Gas Engine. Illustrated detailed description of a double-acting engine. 1200 w. Engr, U. S. A.—March 15, 1905. No. 68390 C.

The Ultimate Limit of Speed in Gas Engines. Herbert L. Towle. Discusses the limit imposed by engineering conditions for steady and continuous running of automobile motors, and gasoline marine engines. 3000 w. Am Mach—Vol. 28, No. 10, 1905. No. 68236.

1,200 Horse-Power Gas Engine. Illustrated detailed description of a blowing engine recently built in France. 800 w. Engr, Lond—March 17, 1905. No. 68669 A.

Gas Turbine.

Practical Investigations in the Gas Turbine Problem. Dr. Charles E. Lucke. A review of experiments in the mechanical laboratory of Columbia University, showing that the kinetic energy of expanding gases is not effectively converted into work by free expansion in simple nozzles. 2500 w. Engineering Magazine—April, 1905. No. 68725 B.

Ignition.

Action of Different Kinds of Ignition Sparks. René M. Fetard. Brief explanation of the three different classes of sparks. 900 w. Automobile—Feb. 25, 1905. No. 68072.

The Spark Coil. From *Horseless Age*. Explains briefly the phenomenon of electromagnetic induction and the nature of the contact spark and the jump spark, and gives an illustrated description of the spark coil. 3800 w. Sci Am Sup—March 4, 1905. No. 68124.

Maynard Motor.

The New Maynard Internal Combustion Motor (Nouveau Moteur à Explosions ou Combustion Interieure dit Moteur Maynard). E. Maynard. A description of an improved internal-combustion motor in which no water jacket or other cylinder-cooling device is used. 2000 w. Rev Technique—Feb. 25, 1905. No. 68425 D.

Producer Gas.

The Gasification of Fuels in Producers, especially for the Production of Power Gas (Die Vergasung der Brennstoffe in Generatoren, insbesondere für Kraftgasbetriebe). Karl Kutzbach. A graphical analysis of the thermochemical reactions involved in the operation of gas producers. 4500 w. Zeitschr d Ver Deutscher Ing—Feb. 18, 1905. No. 68400 D.

The Riche Gas Producer in Connection with Mining Power Plants. Dr. Alfred Gradenwitz. An illustrated article giving information relating to this type of gas producer intended for generating gas from any description of wood waste as well as from similar ligneous matter, agricultural residues, &c. 1000 w. Min Rept—March 9, 1905. No. 68289.

Starting.

High-Pressure Compound Air Compressors (Hochdruck Verbundkompressoren). Describing special forms of compressors for furnishing a supply of compressed air for starting large gas engines. 800 w. Stahl u Eisen—March 15, 1905. No. 68444 D.

HEATING AND COOLING.

Indirect Coil.

Test of an Indirect Heater Coil. S. C. Root. The object of the test was to determine exactly the amount of steam condensed in an indirect coil, under varying conditions. Ills. 2000 w. Jour Assn of Engng Socs—Feb., 1905. No. 68686 C.

Office Building.

Heating and Air Washing in a Works Office Building, Pittsburg. Illustrates and describes a fan system installed in the heart of the mill district of Pittsburg. 1000 w. Eng Rec—March 18, 1905. No. 68397.

Refrigeration.

Ammonia Condensers. John Levy. Calls attention to defects in the older ammonia condensers, and considers the shell condenser the best form. Ills. 1200 w. Ice & Refrig—March, 1904. No. 68178 C.

Regulators.

Regulators for Low Pressure Steam Heating. Charles F. Hauss. Brief illustrated descriptions of some German constructions. 1400 w. Met Work—March 4, 1905. No. 68131.

Steam Heating.

Steam Heating in Connection with Condensing Engines. Reginald Pelham Bolton. Read before the Am. Soc. of Heat & Ven. Engrs. A discussion of the use of exhaust steam from condensing engines, and reporting a series of tests. 2700 w. Met Work—March 25, 1905. No. 68399.

Steam Heating Principles. Prof. William J. Baldwin. The second lecture of the course of eight on Heating and Ventilating at the Brooklyn Polytechnic Inst.'s College of Arts and Engng. Considers a closed or gravity system of steam heating in the present article. 5500 w. Sci Am Sup—March 11, 1905. No. 68251.

Ventilation.

The Ventilation of Factories and Workshops. F. S. Lister. Discusses methods by which effective ventilation is secured, especially the "Exhaust" system, and the "Plenum" system, favoring the latter. 3000 w. Builder—March 18, 1905. No. 68638 A.

HYDRAULICS.

Dynamics.

Experiments on the Dynamics of Fluids. Dr. George Finzi and Dr. Nicholas Soldati. A study of the variation of pressure, produced by a given movement, in every point of the body surface. Ills. 3800 w. Engng—March 17, 1905. Serial. 1st part. No. 68656 A.

Flow.

Flow of Water Through Pipes Fed by Reservoirs. Samuel Diescher. Describes experimental investigations, stating the conclusions. General discussion. Ills. 11700 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68569 D.

Hydraulic Power.

The Hydro-Mechanical Arrangement of Recent Austrian Electrical Stations (Hydromechanische Einrichtungen von Neueren Oesterreichischen Elektrizitätswerken). Gustav Witz. Illustrating and describing the pipe line, water-wheels, and general arrangement of the new plant on the Sill, supplying 15,000 h. p. to the city of Innsbruck. 3000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 24, 1905. No. 68459 D.

Impulse Wheels.

Water Turbines. The present number gives a study of tangential flow. 450 w. Prac Engr—March 3, 1905. Serial. 1st part. No. 68522 A.

Meters.

See Mechanical Engineering, Measurement.

Stream Gauging.

See Civil Engineering, Measurement.

Turbines.

Comparative Experiments with Low-Pressure Reaction Turbines (Vergleichende Untersuchungen an Reaktions-Niederdruckturbinen). Dr. Franz Prasil. A very complete account of experiments made at the Zurich Polytechnic upon turbines of the Francis type. Serial. Part I. 1800 w. Schweiz Bauzeitung—Feb. 18, 1905. No. 68496 B.

MACHINE WORKS AND FOUNDRIES.

Boring Mill.

A New Boring Mill. Illustrates and describes a mill of the extension type. 800 w. Am Mach—Vol. 28, No. 10. No. 68238.

Cams.

The Layout and Construction of Cams. Charles F. Smith. Explains the order of work when laying and making cams, the design of a cam operated machine, laying out a single cam, &c. Ills. 3000 w. Am Mach—Vol. 28, No. 11. Serial. 1st part. No. 68322.

Car Shop Tools.

Tools Used in the United States for Railroad Car Work (Outils Employés aux Etats Unis pour l'Usinage des Roues de Voitures et Wagons). M. Oudet. An illustrated description of wheel lathes, slotters, boring mills, and other tools of American design for car-shop work. 7500 w. Rev Gen de Chem de Fer—Jan., 1905. No. 68431 G.

Castings.

Casting Round Flasks in Cores. H. J. M'Caslin. Illustrates and describes a method of casting round flasks of large diameter in cores with satisfactory results. 500 w. Foundry—March, 1905. No. 68097.

The Defects in Ingot-Iron Castings. Prof. K. Hermann Wedding. Special consideration of the open-hearth process, considering blow-holes, shrinkage cavities, air bubbles, steam cavities, surface cracks, &c. Ir & Steel Mag—March, 1905. No. 68510 D.

Chains.

A New Belgian Process of Manufacturing Weldless Chains. Emile Guarini. Illustrates and describes a process of annular rolling, due to M. Massin. 1300 w. Sci Am Sup—March 11, 1905. No. 68252.

Core Ovens.

Automatic Core Ovens Using Oil as Fuel. S. E. Barnes. Read before the Phila. Found. Assn. Describes a system for burning oil which has been found safe, economical and convenient. Short discussion. 1800 w. Foundry—March, 1905. No. 68098.

Cranes.

Seventy-Ton Electric Travelling Crane. Illustrated description of an electric traveller and gantry which has been constructed for the Natal Government. 500 w. Eng, Lond—March 10, 1905. No. 68547 A.

The Graphical Analysis of a Simple Jib Crane. A. L. Westcott. An explanation of graphic statics as applied to a jib crane. 800 w. Am Mach—Vol. 28, No. 12. No. 68579.

Dies.

Die and Bender for Circuit Breaker Clips. W. F. Hoffman. Illustrated description. 400 w. Am Mach—Vol. 28, No. 11. No. 68325.

Drafting.

Bridge Office Drafting Rules. H. G. Tyrrell. Gives rules drawn up as a general guide, which may be modified to suit particular cases. 5500 w. Eng News—March 23, 1905. No. 68582.

Drafting Room Practice. Ralph E. Flanders. Shows some of the ways in which the drafting room may lighten the labors of the workmen, and advance the industry. Considers the routine office work of a typical shop. 6000 w. Mach, N. Y.—March, 1905. No. 68162 C.

Electric Driving.

Electric Driving in Wood-Working Shops. Results of a series of experiments, carried out for determining the power required for various wood-working machine tools under different conditions. 1800 w. Elect'n, Lond—Feb. 3, 1905. No. 68138 A.

Electrical Works.

The Brush Electrical Engineering Company's "Falcon" Works. Illustrated detailed description. 1500 w. Elec Rev, Lond—March 17, 1905. Serial. 1st part. No. 68650 A.

The Western Electric Co.'s Factory, North Woolwich. Illustrates and describes these works which have recently made extensive changes. 3000 w. Elec Rev, Lond—March 3, 1905. No. 68304 A.

Flywheels.

Boring, Turning and Keyseating Flywheels on a Pit Lathe. Illustrated description of the application of a pit lathe to flywheel making. 700 w. Am Mach—Vol. 28, No. 10. No. 68239.

Foundry Methods.

Foundry Methods of the Landis Tool Company. F. A. Halsey. Illustrates and describes various methods of work of particular interest. Molding, chilling process, &c. 1700 w. Am. Mach—Vol. 28, No. 9. No. 68100.

Grinding.

Improved Protection Devices for Artificial Grinding Wheels (Nouveaux Protecteurs pour Meules Artificielles). Henri Manny. Illustrated descriptions of the devices receiving the prizes of the Association of French Workmen against accidents. 1500 w. 1 plate. Génie Civil—March 4, 1905. No. 68416 D.

Modern Commercial Grinding. W. Muston. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Deals with plain or taper cylindrical work, ground on its external surface. 4500 w. Mech Engr—March 11, 1905. No. 68523 A.

Some English Grinding Machinery. Illustrated descriptions of recent English types. The most distinctive features are the self-oiling-dust proof bearings, which are extra long and of a large diameter, and driving pulleys, which are extra wide and of large diameter. 900 w. Ir Age—March 9, 1905. No. 68241.

Tool Grinders. T. S. Bentley. Briefly traces the history of tool grinding, and considers the cutting power of a wheel, the various substances of which wheels are made, their wear, &c. 3800 w. Prac Engr—Feb. 24, 1905. Serial. 1st part. No. 68208 A.

Hardening.

A New Hardening Furnace. Illustrates and describes a furnace invented by S. N. Brayshaw, which makes use of a salt bath for heating the work. 800 w. Am Mach—Vol. 28, No. 11. No. 68326.

High Speed Tools.

New Machine-Tools for High-Speed Steel (Neue Werkzeuge für Hohe Arbeitsgeschwindigkeit). Alfred Haussner. A discussion of modern methods of cutting with high-speed steels, and their influence upon machine-tool design. 7000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 4, 1905. No. 68705 D.

Lathes.

Heavy Turret-Lathe for 6-in. Black Steel Bars. Illustrated detailed description of a very powerful turret-lathe designed to take full advantage of the cutting capacity of modern tools. Built at Cleveland, Ohio. 1200 w. Engng—March 17, 1905. No. 68660 A.

Lathe for Rotors of Large Steam Turbines at Clydebank, N. B. Illustrations, with brief description. 450 w. Engng—March 10, 1905. No. 68542 A.

Milling Machine.

Vertical Spindle Milling Machine with Constant Speed Drive. Illustrated description of a new machine and its operation. 1200 w. Am Mach—Vol. 28, No. 9. No. 68103.

Molding.

Making a Spiral Drum in Loam. Joseph Horner. An illustrated detailed description of the molding of a large spiral drum, or screw barrel, for a powerful Titan crane. 2500 w. Foundry—March, 1905. No. 68099.

Molding Crooked to Make Straight Castings. Thomas Mack. Describes method used to overcome warping. Ills. 800 w. Am Mach—Vol. 28, No. 10. No. 68240.

Molding a Rope Drive Flywheel. R. H. Palmer. Illustrates and describes the method used. 900 w. Am Mach—Vol. 28, No. 11. No. 68324.

Moulds.

Facing Moulds for the Production of Fine Surface Castings. Directions for preparing the moulds for finely finished castings. 1200 w. Prac Engr—Feb. 17, 1905. No. 68060 A.

Notching.

An Armature Disk Notching Attachment. H. B. M'Cabe. Illustrated detailed description of the attachment and its working. 900 w. Am Mach—Vol. 28, No. 10. No. 68237.

Planer.

A New Variable Speed Planer with Air-Actuated Friction Clutches. Illustration, with description. 1200 w. Am Mach—Vol. 28, No. 9. No. 68101.

96-Inch Planer, with Friction Clutches, Operated by Air. Illustrated description of a planer intended for work not exceeding 96 ins. wide, 96 ins. high and 20 ft. long. 1100 w. Ry & Loc Engng—March, 1905. No. 68158 C.

Shops.

See Railway Engineering, Permanent Way and Buildings.

Tool Design.

The Rational Design of Machine Tools. Editorial comment on a recent lecture by Prof. J. T. Nicolson before the graduates of the Inst. of Mech. Engrs. on "Results of Force Measurements with Cutting Tools and the Application to Lathe Design." 2000 w. Engng—Feb. 24, 1905. No. 68220 A.

Wheel Foundry.

The New Wheel Foundry of the Pennsylvania at Altoona. Illustrated detailed description of new works and their equipment. 3800 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68370.

Woodworking.

Universal Woodworking Machine. Illustrated description of a new type of machine which can be applied to a variety of purposes, such as trenching, recessing, cross-cutting, grooving, moulding, &c. 1200 w. Engng—Feb. 24, 1905. No. 68223 A.

Works-Laboratory.

Labor Saving Appliances in the Works-Laboratory. Edward Keller. Illustrates and describes appliances introduced in the laboratory of the Anaconda Copper Mining Co., in Baltimore, Md. 3500 w. Am Inst of Min Engrs—March, 1905. No. 68568.

MATERIALS OF CONSTRUCTION.

Blackings.

Foundry Blackings. N. W. Shed. Information in regard to the various kinds of blackings used and the work for which they are suited, method of testing, &c. 1200 w. Foundry—March, 1905. No. 68095.

Brasses.

Practical Methods of Analysis for Brasses and Bronzes. W. W. Corse. Explains methods of analysis and their importance in the brass foundry. 2000 w. Foundry—March, 1905. No. 68096.

Bronze.

A Special Constituent Obtained by Tempering Aluminum Bronze (Constituant Spécial Obtenu dans la trempe d'un Bronze d'Aluminium). Pierre Breuil. Describing an especial crystalline form occurring in alloys of copper and aluminum when tempered at 650 to 750 degrees C. 1000 w. Comptes Rendus—Feb. 27, 1905. No. 68421 D.

Cast Iron.

Specifications for Cast Iron (Vorschriften für die Lieferung von Gusseisen). A. Martens. A review of the specifications of the German Society of Foundrymen by the director of the Charlottenburg testing laboratory. 4000 w. Zeitschr d Ver Deutscher Ing—March 11, 1905. No. 68446 D.

Corrosion.

The Corrosion of Metals. Prof. A. H. Sexton. A discussion of the corrosion of metals in common use under the conditions in which they are most generally used, and the means that have beeen found most efficient for protecting them. 2500 w. Mech Engr—Feb. 18, 1905. Serial. 1st part. No. 68061 A.

Impact Testing.

Impact Testing of Notched Bars. Illustrates and describes two recent types of machine invented by M. G. Charpy, which he considers will meet the requirements of all practical cases. 2000 w. Engr, Lond—March 10, 1905. No. 68548 A.

Metallography.

Equipment and Work of Metallographical Laboratories in Germany. E. P. Buffet. Extracts from descriptions appearing in German engineering periodicals, describing two recent plants. 1800 w. Ills. Am Mach—Vol. 28, No. 11. No. 68323.

Notes on the Etching of Steel Sections. William Cobb Smeaton. Discusses the four general classes of etches: Heat-tinting; electro-deposition; polishing in bas-relief; solvent etches. 2500 w. Ir & Steel Mag—March, 1905. No. 68511 D.

The Scientific Development of the Art of Polishing (Les Enseignements Scientifiques du Polissage). MM. F. Osmond & G. Cartaud. A discussion of modern methods of producing a high polish upon metallic surfaces in connection with researches into the physical structure of materials. 5000 w. Rev Gen des Sciences—Jan. 30, 1905. No. 68702 D.

Pig Iron.

A Classification System for Foundry Pig Iron (Klassifikations Vorschläge für Giessereiroheisen). Dr. Wüst. A discussion of the composition and properties of German irons and a proposition to grade them according to the use to which the castings are to be applied. Three articles. 9000 w. Stahl u Eisen—Feb. 15, March 1, 15, 1905. No. 68437 each D.

Pig-Irons and Their Use in the Foundry and Forge. E. Adamson. Abstract of a paper read before the Manchester Assn. of Engrs. Gives table showing the sources of ore supply, and discusses hematite pig-iron, quality, grading, &c. Ir & Coal Trds Rev—March 3, 1905. No. 68319 A.

Pipe.

Steel and Iron Wrought Pipe. Frank N. Speller. Read at meeting of the Can. Min. Inst. Reviews the results of investigations made of threading and relative durability. Ills. 3000 w. Ir Ag—March 2, 1905. No. 68087.

Steel.

Special Steels (Aciers Speciaux). J. Malette. A general and systematic review of modern alloy steels, with tabular view of their composition and properties. 2000 w. Rev Technique—Feb. 25, 1905. No. 68426 D.

Steel as Applied to Motor Car Construction. J. S. Critchley. Excerpt from a paper read before the Automobile Club (London). The difficulties in annealing, testing, vanadium steel, &c. 1500 w. Auto Jour—March 11, 1905. No. 68521 A.

Steel Protection.

Protecting Steel Structures. Reports the results of interesting experiments of Louis H. Barker, the testing of paints, and the success obtained by using paraffin paper as a substitute for covering metal. Ills. 1500 w. Ry Age—March 24, 1905. No. 68672.

Stresses.

The Bending Stresses in Curved Prismatic Bodies (Beitrag zur Bestimmung der Biegungsspannung in Gekrümmten Stabförmigen Körpern). Ernst Werner. An analytical examination of the stresses on loaded beams when curved. 1800 w. Zeitschr d Ver Deutscher Ing—Feb. 18, 1905. No. 68402 D.

Torsion.

The Deformation Work in Torsion (Zur Frage: Formänderungsarbeit bei Torsion). Prof. Zschetzsche. A mathematical discussion, deriving formulas for computing the work of torsion for bodies of various sections. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 11, 1905. No. 68706 D.

Wire Ropes.

Bending Stresses in Wire Ropes. Samuel Diescher. Relates to bending stresses as they occur in the wires of ropes bent around sheaves in the operation of hoisting machinery, inclined planes, cable railways, &c. Ills. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1905. No. 68090 D.

The Use and Abuse of Wire Rope. L. C. Moore. The discussion is confined to cast steel and the higher grades of wire rope. Gives explanation of the methods of preparing wire for these grades. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1905. No. 68091 D.

MEASUREMENT.

Friction.

A Note on Sliding Friction (Sur le Frottement de Glissement). L. LeCornu. A paper before the French Academy, showing that the consideration of the elasticity of the material explains the apparent inconsistencies in Coulomb's law. 1000 w. Comptes Rendus—March 6, 1905. No. 68449 D.

Metric System.

Metric System in Great Britain. Report of the Decimal Association. (Abstract.) Considers British legislation on this subject, the action taken by various associations, &c. 2000 w. Am Mach—Vol. 28, No. 9. No. 68104.

Recorders.

Registering Errors of Recording Levers (Erreurs d'Inscription des Levièrs Enregisteurs). F. Cellerier. An examination of the causes of error in multiplying levers, such as are used in indicators, barographs, testing-machine recorders, etc. 7500 w. Revue de Mécanique—Jan. 31, 1905. No. 68464 E + F.

Testing-Machine.

A New Testing-Machine for Reversals of Stress. J. H. Smith. Brief account, with illustrations, of a machine which is to form a part of the Mechanical Engineering Department of the Municipal Technical Inst. of Belfast. 1500 w. Engng—March 10, 1905. No. 68541 A.

Water Meters.

The Measurement of Water (Le Jaugeage de l'Eau). A description of the Venturi meter, and its applications in England and on the Continent in connection with the metering of municipal water supplies. 2500 w. Revue Technique—Feb. 10, 1905. No. 68423 D.

POWER AND TRANSMISSION.

Brakes.

More Notes on Band Brake Design. C. F. Blake. Considers the holding power due to the wedging of the blocks in the V-grooved brake wheel. Diagrams. 1500 w. Mach, N. Y.—March, 1905. No. 68160 C.

Cableway.

Cableways and Railways (Seilbahn und Eisenbahn). A description of a very Extensive Cableway installation, conveying iron ore from the Anmetz mine to the Friede furnace at Kneuttingen, the capacity being 5½ ton-kilometres per year. 1800 w. 1 plate. Stahl u Eisen—March 1, 1905. No. 68438 D.

Erecting Radial Cableways for Gold Mining in Mexico. Illustrated description of an installation of two 800-ft. radial traveling cableways, each with a capacity of 100-yds. of gravel per hour, for stripping gold-bearing gravels from the bottom of cañons. 1200 w. Eng Rec—March 11, 1905. No. 68267.

Clutch.

An Improved Clutch (Sur un Nouvel Embrayage). M. Hérisson. Describing an improved form of friction clutch giving gradual engagement without excessive wear from sliding friction. 1000 w. Comptes Rendus—Feb. 6, 1905. No. 68418 D.

Compressed Air.

Graphics of Boyle's Law. E. F. Schaefer. A discussion of the law of the relations of pressure and volume of compressed air and other gases, showing the method of plotting them as a graphical diagram. 1500 w. Air Power—April, 1905. No. 68728.

Ignitions and Explosions in the Discharge Pipes and Receivers of Air Compressors. Alex. M. Gow. A report of extensive investigation undertaken to ascertain what precautions should be taken to guard against such accidents. A valuable paper. 5700 w. Eng News—March 2, 1905. No. 68113.

Specifications for an Air Compressor. Gives specifications for an air compressor for an air-life pumping plant at Spring Lake, N. J. 1500 w. Eng News—March 2, 1905. No. 68114.

Electric Driving.

An Induction-Motor Factory Installation. Illustrated description of the new electrical generating and distribution system of the New York Glucose Co., at Edgewater, N. J. 2500 w. Elec Wld & Engr—March 18, 1905. No. 68535.

Electric Motor Equipment of the Worthington Hydraulic Works. Illustrated description of a new plant in Harrison, N. J. 2400 w. Elec Wld & Engr—March 18, 1905. No. 68537.

Electric Power Equipment of a Modern Machine Shop. Illustrates and describes the electrical equipment of the Link-Belt Engineering Co., near Philadelphia. Examples of both individual motor and group driving. 3000 w. Elec Wld & Engr—March 18, 1905. No. 68536.

Electric Power in Factories. A. W. Henshaw. Considers the reasons for the growing popularity of this system, giving information helpful in determining the system best adapted to any given condition. 6000 w. Elec Wld & Engr—March 18, 1905. No. 68533.

Individual Motor-Drive in a Type Foundry. Illustrates and describes the application of individual motor drives for small machines at the factory of the American Type Founders' Company, at Communipaw, N. J. 2500 w. Elec Wld & Engr—March 18, 1905. No. 68532.

The Application of Electric Motors to Machine Tools. George T. Hanchett. Presents the advantages of driving tools directly by motors, considers variable speed control, and the methods. 3300 w. Elec Wld & Engr—March 18, 1905. No. 68531.

The Application of Electricity to a Large Manufacturing Industry. Illustrated description of the new manufacturing plant of the Ingersoll-Sergeant Drill Company. 2000 w. Elec Wld & Engr—March 18, 1905. No. 68534.

Gas Pumping.

Natural Gas Pumping Plant at Hundred, W. Va. An illustrated description of the pumping plant of the Carnegie Natural Gas Company, erected by the Rand Drill Company, delivering 30,000,000 cubic feet of gas from West Virginia to the works of the U. S. Steel Corporation in the vicinity of Pittsburgh, Pa. 2000 w. Air Power—April, 1905. No. 68726.

Link Belts.

The Transmission of Power by Means of Link Belts. A. B. Morrison, Jr. An illustrated explanation of the action of block chains, roller chains, and silent chains, with suggestions on the selection for any particular installation. 4000 w. Engr, U. S. A.—March 1, 1905. No. 68155 C.

Power Cost.

The Cost of Installation and Operation of Various Sources of Power (Spese di Impianto e di Esercizio di Diversi Sistemi per la Produzione dell' Energia). A comparison of the costs of motive power derived from steam engines, steam turbines, Diesel motors, and gas engines. 3000 w. L'Ingegneria e l'Industria—Feb. 15, 1905. No. 68713 D.

Ropes.

A New Scheme in Rope Transmission. George F. Willis. Illustrated description of a new system which can be applied to a drive using any number of ropes. 900 w. Power—March, 1905. No. 68170 C.

Rope Driving. C. Boysen. Discusses the application of hemp ropes for the transmission of power, its advantages, the two systems in use, &c., giving formulas and equations for solving problems of rope drives. 1500 w. Power—March, 1905. No. 68168 C.

Shafts.

Combined Bending and Torsion in Shafts. George A. Lister. Explains method of proportioning in designing shafts subjected to both bending and twisting moments. 800 w. Mech Engr—March 4, 1905. No. 68300 A.

Telpherage.

Transportation of Materials by Electricity. A. Frederick Collins. Illustrates and describes the equipment installed at the works of the Baker Chocolate Company, at Milton, Mass., where overhanging electric telpher trains convey materials used. 1200 w. Sci Am—March 18, 1905. No. 68328.

Windmills.

Powerful German Windmills. Charles B. Hayward. Illustrations, and descriptions, of interesting types. 1600 w. Sci Am—March 25, 1905. No. 68598.

The Old Dutch Windmill at Golden Gate Park, San Francisco. An illustrated article considering the features of engineering interest in the construction of this windmill, which is the largest wind motor in the United States. 4500 w. Jour of Elec—March, 1905. No. 68286 C.

Worm Gearing.

Worm-Gear Transmission for Electric Tramway Cars (Emploi des Vis sans Fin dans les Transmissions des Tramways Electriques). H. Somach. Details of a successful electric truck with worm gear transmission, designed by the Oerlikon Works. 1000 w. 1 plate. Génie Civil—March 11, 1905. No. 68448 D.

STEAM ENGINEERING.

Adiabatics.

Determination of Exponents of Adiabatics. Thomas M. Gardner. Showing that no simple relationship exists between the values of adiabatic exponents and specific, latent or total heats. 1100 w. Jour Fr Inst—March, 1905. No. 68345 D.

Boilers.

Difficulty of Combining Efficiency of Boilers with Their Safe Working. C. E. Stromeyer. Read before the Leeds Univ. Engng. Soc. Discusses the troubles due to high temperatures and the possibility of remedying them. 2500 w. Prac Engr—Feb. 24, 1905. No. 68209 A.

Chimneys.

Chimneys. F. H. Davies. Discusses the questions that must be studied in properly designing chimneys. 1700 w. Elec Engr, Lond—March 10, 1905. No. 68525 A.

Coal Testing.

Testing Coals and Lignites at the St. Louis World's Fair. Edward W. Parker. The first portion of a complete review of the equipment and work of the coal-testing plant of the United States Geological Survey at St. Louis. 4000 w. Engineering Magazine—April, 1905. No. 68721 B.

Condensers.

Central Condensing Plant at Neuves Maisons (Zentral - Oberflächenkondensation in Neuves Maisons). Fr. Frolich. Illustrated description of the new central condensing plant of the Chatillon, Commentry Co., capable of condensing 125,000 kilogrammes of steam per hour. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 18, 1905. No. 68401 D.

Cylinder Dimensions.

Cylinder Dimensions and Engine Economy. Sterling H. Bunnell. Gives diagrams, illustrating the principles governing the wire selection of the dimensions for an engine, with explanatory remarks. 2400 w. Power—March, 1905. No. 68169 C. 1905. No. 68346 D.

Engine Bearings.

Adjustment and Alloys for Engine Shaft Bearings. William Turner. Abstract of a paper read before the Manchester (Eng.) Assn. of Engrs. 1800 w. Engr, U. S. A.—March 15, 1905. No. 68391 C.

Engines.

Compound Corliss Spinning Mill Engine. Illustrated description of a fine example of a modern British mill engine. 2400 w. Engr, Lond—March 3, 1905. No. 68313 A.

Main Engines of the American Steamship Dakota. Illustrated detailed description of engines of more than usual interest. 2000 w. Marine Rev—March 16, 1905. No. 68500.

The Modern Horizontal Steam Engine as Exemplified in British Practice. Leo. H. Jackson. Gives illustrated descriptions of designs manufactured as standard types by British makers. 3500 w. Cassier's Mag—March, 1905. Serial. 1st part. No. 68127 B.

Evaporation.

Multiple Effect Evaporation. Charles Day. Read before the Manchester Assn. of Engrs. Describes the principles on which the system of multiple evaporation is based, and gives illustrations of its application in daily practice. 3400 w. Mech Engr—Feb. 18, 1905. No. 68062 A.

Feed Water.

A Simple Method of Calculating Water Analyses and Amounts of Substances to be Added for Preventing Scale and Corrosion of Boilers. Samuel S. Sadtler. Gives curves and tables which are applicable to several schemes of analysis, and save time. 1200 w. Jour Fr Inst—March,

The Chemical Purification of Boiler Feed-Water. George E. Walsh. A discussion of the different treatments of impure feed-water for boilers, and of water-softening and purifying machines. 1500 w. Am Elect'n—March, 1905. No. 68140.

Flow.

The Theory of the Flow of Elastic Fluids and the Divergent Nozzle. M. Blieden. A mathematical study. 3000 w. Engr, Lond—Feb. 17, 1905. Serial. 1st part. No. 68057 A.

Fuel Waste.

Loss of Fuel by Presence of Combustible in Refuse. Hartley Le Huray Smith. Gives a method of calculating the fuel wasted and the graphical representation of it by a curve sheet covering ordinary practice. 500 w. Power—March, 1905. No. 68173 C.

Lubrication.

The Lubrication of Steam Engines and Machinery. Considers an example showing the loss due to low efficiency, and discusses the lubrication of cylinders and valves and the motion work of engines. 2000 w. Mech Engr—Feb. 25, 1905. Serial. 1st part. No. 68210 A.

Oil Fuel.

On the Economy of Steam Power Plants Using Oil Fuel. Presents tables and calculations referring to maximum economy under duty trial, explaining methods. 2800 w. Jour of Elec—March, 1905. No. 68287 C.

Pipes.

Steam Pipes. R. T. Strohm. Considers only the main steam pipes to and from the engines, discussing the selection of material and its erection, method of determining the loss of pressure to be expected, arrangements, tight joints, etc. 1800 w. Am Elect'n—March, 1905. No. 68142.

Safety Valves.

High-Lift Safety Valves (Sicherheitsventile, Insbesondre Solche mit Hohem Hub). P. H. Rosenkranz. An examination of the forms of valves and seats best adapted to give effective relief to steam pressure. 2500 w. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68408 D.

Specific Heat.

The Calorific Properties of the Vapor of Water at High Temperatures (Die Kalorischen Eigenschaften des Wassers und seines Dampfes bei Hohen Temperaturen). C. Dieterici. A discussion of the determination of the specific heat of water and of superheated steam. 3500 w. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68409 D.

Superheating.

A Compound Superheater. R. Hildebrand. An account of the power plant of the tramway station, Luisenstrasse, Berlin, Germany, which has a maximum capacity of 12000 h.-p., using separately fired superheaters. Diagrams. 900 w. Power—March, 1905. No. 68174 C.

Superheater Duties and Design. Franz Koester. A detailed account of a test made at the municipal plant in Manheim, Germany, in which Herring superheaters were used. 1200 w. Power—March, 1905. No. 68172 C.

The Superheating of Steam and its Influence on Engine Economy. R. M. Neilson. The second paper discusses the results secured by the use of superheated steam, with data and results of tests. 4000 w. Engineering Magazine—April, 1905. No. 68721 B.

Turbines.

Impulse and Reaction Turbines. An illustrated article explaining the distinction between the impulse and reaction turbine. 1200 w. Mach, N Y—March, 1905. No. 68161 C.

Reports on Tests of a Centrifugal Pump and a "Sirocco" Blower Driven by De Laval Steam Turbines. Illustrates and describes apparatus used, and methods of testing, giving results. 4500 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68515 H.

Steam Turbines (Dampfturbinen). Johann Trnovsky. A general account of the principles of steam-turbine design, with illustrations of the leading commercial types. Two articles. 6000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 14, 21, 1905. (No. 68704 each D.

The Determination of the Elements of Steam Turbines (Determination des Eléments des Turbines à Vapeur). M. Kopp. Applying the method of Boulvin to the construction of the entropy diagram for the turbine in connection with problems of design and proportion. 7500 w. Revue de Mécanique—Feb. 28, 1905. No. 68466 E + F.

The Phenomena of Flow in the Nozzles of Steam Turbines (Les Phénomènes d'Econlement dans les Tuyères des Turbines à Vapeur). A. Koob. A translation of the paper of Koob from the German, showing the application of the temperature-entropy diagram to turbines. 3500 w. Revue de Mécanique—Jan. 31, 1905. No. 68465 E + F.

Valves.

Locomotive Valves and Valve-Gears. W. F. M. Goss. Explains the requirements, and describes the Stephenson valve-gear, discussing its merits and defects. Improved valve gears, valve setting, foreign valve-gears, etc., are also briefly considered. 5500 w. Pro S & S-W Ry Club—March 16, 1905. No. 68341 E.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Anthracite Coal Fields of Pennsylvania. Arthur H. Storrs. A description of these deposits, with information concerning the methods of mining, and other matter of interest. Ills. 3000 w. Min Mag—March, 1905. No. 68355 C.

The Preparation of Anthracite. Notes the changes that have taken place in the practice during the past twenty-five years. Ills. 2300 w. Mines & Min—March, 1905. No. 68229 C.

Briquettes.

Briquetted Fuels, Foreign and Domestic. G. M. Randall. Gives a brief resumé concerning the manufacture of artificial fuel in several foreign countries, and matters of related interest. 4000 w. Power—March, 1905. No. 68167 C.

Coal Field.

The Tug River Coal Field. Henry M. Payne. A description of the general geology of the region and of the qualities of the coal. 1000 w. Ills. Mines & Min—March, 1905. No. 68230 C.

Coal Regions.

Seaboard Coal Regions Along the Baltimore and Ohio Railroad. Beverley S. Randolph. Report of the Fairmont, Tunnelton, Georges Creek, and Meyersdale regions. Ills. 1500 w. Min Mag—March, 1905. No. 68357 C.

The Ohio and Indiana Coal Fields. George A. Ashley. Describes the deposits and method of mining. Ills. 1400 w. Min Mag—March, 1905. No. 68358 C.

Coal Testing.

See Mechanical Engineering, Steam Engineering.

Coke.

The Connellsville Coke Region. Thomas W. Keighley. A description of this region, the deposits, method of mining, the coke ovens, and report of a flourishing condition. 3800 w. Min Mag—March, 1905. No. 68356 C.

The Making of By-Product Coke. Edwin A. Moore. Abstract of an address to the Phila. Found. Assn. Remarks on the rapid replacement of beehive ovens by-product ovens, describing the operation of a plant at Camden, N. J. 1100 w. Eng & Min Jour—March 2, 1905. No. 68135.

To Purify Pit Water at Coke Works. A brief explanation of the system devised by Prof. John W. Langley. 800 w. Ir Trd Rev—March 23, 1905. No. 68590.

Colorado.

Coals of the Southern Colorado or the Walsenburg and Trinidad Region. A. Lakes. Describes the location of the deposits and the composition of the coal. Ills. 1400 w. Min Rept—March 2, 1905. No. 68203.

The La Plata or Southwestern Colorado Coal Field. A. Lakes. Describes the geology and the deposits of this region. Ills. 1400 w. Min Rept—Feb. 23, 1905 No. 68076.

Conveyors.

Mechanical Coal Conveying at the Face, with Especial Reference to the "Blackett" Conveyor and Its Work at Derwent Colliery, Co. Durham. Harry Palmer. From the *Jour. of the Brit. Soc. of Min. Students.* Ills. 1800 w. Ir & Coal Trds Rev—March 17, 1905. No. 68655 A.

Electric Power.

Application of Electric Power in Collieries. G. M. Brown. Abstract of a paper read before the Rugby Engng. Soc. Discusses the advance in the application of electricity to mining due to the introduction of the polyphase alternating current induction motor. 2700 w. Elect'n, Lond—March 17, 1905. No. 68653 A.

Explosions.

Coal-Mine Explosions in Kansas. Report of a commission appointed to investigate the causes. 2000 w. Eng & Min Jour—March 16, 1905. No. 68362.

Flat Top.

Flat Top Mine. Samuel H. Lea. Describes a typical coal mine in the Birmingham, Ala., district, with the characteristics and manner of working. 3500 w. Mines & Min—March, 1905. No. 68233 C.

Haulage.

High-Tension Underground Hauling-Gear. Illustrates and describes the electric haulage recently installed at Durham collieries. 1100 w. Engng—March 17, 1905. No. 68659 A.

Illinois.

The Illinois Coal Field. George S. Rice. Gives location of the deposits, describing methods of mining. 1200 w. Min Mag—March, 1905. No. 68359 C.

Montana.

The Montana Coal Fields. J. P. Rowe. Illustrated description, with account of mining methods and machinery, and remarks on their commercial value. 3500 w. Min Mag—March, 1905. No. 68360 C.

Power Plants.

Economy in the Operation of Coal-Mine Power Plants. F. C. Weber. A discussion of the superiority of the Corliss type of engine over other forms for use in mining power plants. 1200 w. Air Power—April, 1905. No. 68728.

Wyoming.

Rock Springs Coal Mines in Wyoming. Prof. Arthur Lakes. Notes on the formations, the mines, and methods of mining. 2000 w. Mines & Min—March, 1905. No. 68231 C.

COPPER.

British Columbia.

Copper Deposits of the Aspen Grove Camp, Similkameen, Brtish Columbia. Frank Bailey. An illustrated description of this camp, its geological features, deposits, development, etc., with an outline of its history. 1400 w. Min Rept—Feb. 23, 1905. No. 68077.

Flue Dust.

Flues and Flue Dust at Anaconda. C. H. Dougall. Read before the Can. Soc. of Civ. Engrs. Sketches and description of arrangements of the plant which are giving most satisfactory results, and related matters of interest in connection with this copper smelter. 4000 w. Can Min Rev—Feb., 1905. No. 68080 B.

Slag-Car.

A Special Form of Slag-Car. L. J. W. Jones and B. H. Bennetts. Illustrated description of a car in use at the copper blast-furnaces at Tacoma, Wash. 1200 w. Am Inst of Min Engrs—March, 1905. No. 68563.

Stamp Mill.

The Baltic Stamp Mill: Lake Superior Copper Region. Illustrated detailed description of a recently completed mill at Redridge, Mich. 2500 w. Eng News—March 23, 1905. No. 68580.

GOLD AND SILVER.

Alaska.

A Growing Camp in the Tanana Gold Fields, Alaska. Sidney Paige. An account of life and conditions at the Fairbanks camp. Ills. 2500 w. Nat Geog Mag—March, 1905. No. 68225 C.

The Placer Fields of North-Western America. Thomas Tonge. Information obtained from Chester Wells Purington, who recently investigated the placer mining industry of Alaska, in regard to the conditions, cost of mining, and best methods to employ in the different districts. 4000 w. Min Jour—March 18, 1905. No. 68637 A.

Assaying.

On Cupellation and Parting in Ore Assaying. T. Kirke Rose. Notes on methods adopted in the assay of gold ores. 1500 w. Jour Chem, Met & Min Soc of S Africa—Jan., 1905. No. 68517 E.

Bohemia.

Gold Mining at Roudny in Bohemia (Der Golderzbergbau am Roudny in Böhmen). Dr. Oskor Eypert. Describing the application of the modern cyanide process to an old gold working in Bohemia. Two articles. 5000 w. Oesterr Zeitschr f Berg u Huttenwesen—Feb. 18, 25. 1905. No. 68694 each D.

British Columbia.

Mining on Gribble Island, B. C. W. M. Brewer. An account of the geology, characteristics of the gold-bearing ore bodies, development, &c. 1600 w. Min & Sci Pr—March 18, 1905. No. 68634.

Chlorination.

The Effect of Silver on the Chlorination and Bromination of Gold. H. O. Hofman and M. G. Magnuson. An account of a research to find the dissolving power of chlorine-water and of bromine-water upon gold and upon a series of alloys of gold and silver, the operations being carried out in revolving vessels. 3300 w. Am Inst of Min Engrs—March, 1905. No. 68567.

Cyaniding.

Cyanidation of Silver in Mexico. Hugh G. Elwes. Gives reports of experiments showing that a profit can be made where no other available process can give satisfaction. 1000 w. Eng & Min Jour—March 16, 1905. No. 68366.

Laboratory Experiments on the Use of Ammonia and Its Compounds in Cyaniding Cupriferous Ores and Tailings. A. Jarman and E. LeGay Brereton. Read before the Inst. of Min. & Met. A record of valuable experiments made in connection with the treatment of gold ores containing up to 1½ per cent. of copper. 700 w. Min Rept—March 9, 1905. No. 68290.

Relative Merits of Wet and Dry Crushing in Cyanidation. Paul Danckwardt, in Trans. Black Hills Min. Assn. Gives an outline of the leading points which determine the selection of the proper kind of machinery to be used at a mill. 1300 w. Min & Sci Pr—March 11, 1905. No. 68503.

Dredging.

Dredging for Fine Gold in Idaho. Robert N. Bell. Describes the method employed to recover fine gold from the Snake River placer beds. 2000 w. Min Wld—March 11, 1905. No. 68294.

Grinding.

The Influence of Fine Grinding on the Metallurgy of the Precious Metals. A. W. Warwick. Read before the West. Assn. of Tech. Chem. & Met. Discusses recent changes in methods of treating gold ores, the treatment of slimes, and describes machines for fine grinding. Ills. 1200 w. Min Rept—March 2, 1905. Serial. 1st part. No. 68501.

Mexico.

El Oro District, Mexico. Robert T. Hill. An illustrated account of the largest and most important gold-mining camp of Mexico. 3000 w. Eng & Min Jour—March 2, 1905. No. 68133.

Nevada.

The Goldfield District, Nevada. M. D. Draper. An illustrated account of this district, its location, geology, deposits, &c. 4000 w. Min & Sci Pr—March 11, 1905. No. 68502.

Ore Bodies.

Features of the Occurrence of Ore at Red Mountain, Ouray County, Colo. T.

E. Schwarz. Describes certain sections of the Yankee Girl mine, which throw additional light on the geology of this section. Reference is made to the report of F. L. Ransome. Ills. 1800 w. Am Inst of Min Engrs—March, 1905. No. 68561.

Ore Treatment.

Crushing and Cyanidation. F. C. Roberts. Gives results of recent experiments which demonstrated that classification, combined with re-crushing, was the most economical method of obtaining both the greatest crushing duty and high extraction. 2300 w. Eng & Min Jour—March 2, 1905. No. 68137.

Ore Washing.

Ore Washing in Cripple Creek, Colo. Illustrates and describes the practice at the different mines. 2000 w. Min & Sci Pr—Feb. 18, 1905. No. 68079.

Quebec.

The Bed-Rock of the Gilbert River Goldfields, Quebec. John A. Dresser. Read before the Canadian Min. Inst. A brief study of the gold-bearing rocks of this region. 1000 w. Eng & Min Jour —March 23, 1905. No. 68592.

Queensland.

Scottish Gympic Gold Mines. R. Logan Jack. Report on the geology, mining, &c. 5000 w. Queens Gov Min Jour —Jan. 14, 1905. No. 68206 B.

Slimes.

Fluxing of Gold Slimes. Charles E. Meyer. Explains the theory and calculation of flux, giving results. 1200 w. Jour Chem, Met, & Min Soc of S Africa—Jan., 1905. No. 68518 E.

South Africa.

Notes on the Occurrence of Gold in Primary Formations. E. F. Heneage and W. G. Holford. An account of experience during prospecting work in mineralized zones of the older sedimentary formations of South Africa. 3500 w. Jour S Af Assn of Engrs—Nov., 1904. No. 68129 F.

Veins.

Characteristics of Gold-Quartz Veins in Victoria. Waldemar Lindgren. Describes these veins and discusses the theories advanced to explain their formation. 2500 w. Eng & Min Jour—March 9, 1905. No. 68244.

Victoria.

Marine Tertiary Rocks of Victoria. E. J. Alexander. A lecture on the relationship of the auriferous gravels and drifts of Victoria to the marine tertiary rocks. 3000 w. Aust Min Stand—Feb. 2, 1905. No. 68298 B.

Yukon.

Yukon Territory. From the recently issued annual report of the Department of the Interior, giving information of mining, assaying, and related matters. Ills. 4500 w. B C Min Rec—March, 1905. No. 68683 B.

IRON AND STEEL.

Blast-Furnaces.

Blast-Furnace Plant of the "Elba" Società Anonima di Miniere e di Alti Forni at Portoferraio, Elba. Carlo Massa. Illustrated detailed description of the plant. 2800 w. Am Inst of Min Engrs—March, 1905. No. 68566.

Notes on the Evolution of Blast Furnace Recovery Plant. J. Gillespie. Presents some of the steps in the evolution of the blast furnace recovery plant, describing details. Ills. 6500 w. Jour of W of Scot Ir & Steel Inst—Jan., 1905. No. 68689 F.

Briquetting.

Briquetting Plant for Iron Ore (Erzbrikettierungsanlage). H. Zeidler. A detailed description of the plant of the iron works at Kertsch, in Southern Russia. 3500 w. Stahl u Eisen—March 15, 1905. No. 68442 D.

Cast Iron.

See Mechanical Engineering, Materials.

Charging Machines.

Machines for Charging Ingots and Scrap into Open-Hearth Furnaces (Machines à Charger les Lingots et les Riblons dans les Fours à Réchauffer). Describing electric and steam charging machines of recent German design. 1800 w. 1 plate. Génie Civil—Feb. 11, 1905. No. 68411 D.

Cold Blast.

The Use of Cold-Blast Iron for Making Low Steel (Verwendung von Kalt Erblasenen Roheisen zur Flusseisendarstellung). Dr. Geilenkirchen. An examination of the relative suitability of hot and cold blast iron for use in the open-hearth steel process. Serial. Part I. 4000 w. Stahl u Eisen—March 15, 1905. No. 68443 D.

Dry Air Blast.

Dry Blast and Turbo-Blowers (Windtrocknung und Turbogebläse). Prof. W. Mathesius. A study of the removal of moisture from air blast by the use of chemical absorbents. 1800 w. Stahl u Eisen—March 1, 1905. No. 68440 D.

Dry-Air Blast for Blast Furnaces (La Dessication de l'Air dans le Soufflage des Hauts-Fourneaux). G. Chesneau. A review of the criticisms of the Gayley process, urging caution in repeating the experiment. 1200 w. L'Electrochimie—Jan., 1905. No. 68488 D.

The Use of Dried Air in the Blast Furnace. A. Pourcel, in the *Revue de Metallurgie*. A discussion of the Gayley dry blast. 1800 w. Ir & Coal Trds Rev—March 3, 1905. No. 68318 A.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Gas Valves.

Double Gas Valves (Ueber Doppelte Gichtverschlusse). K. Stähler. Describing especially the Buderus double-cone valve for blast furnaces, enabling the gas to be drawn off continuously without interfering with the charging of the furnace. 1800 w. Stahl u Eisen—Feb. 15, 1905. No. 68436 D.

Henry Cort.

The Case of Henry Cort. Charles H. Morgan. On the nature of his inventions, their value to England and to mankind, the meagre remuneration received by him and his family, and the suitable permanent record and recognition of his services. 3300 w. Ills. Am Inst of Min Engrs—March, 1905. No. 68564.

Open-Hearth.

Open-Hearth Furnaces. G. L. Luetscher. An illustrated description of the open-hearth furnace. General discussion. 6000 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68571 D.

Pig Iron.

A New Process for Refining Pig Iron. J. B. Nau. Describes a method devised with the aim of applying it to the preliminary and partial refining of pig iron too high in silicon and phosphorus to be treated economically in the open hearth furnace. Treats of refining pig iron by means of iron ores. 3800 w. Ir Age—March 23, 1905. Serial. 1st part. No. 68555.

See Mechanical Engineering, Materials.

Rolling Mills.

Armor-Plate Rolling Mill for the French Government (Panzerplattenwalzwerk der Französischen Marineverwaltung). W. Schnell. Illustrating heavy reversing rolling mill built in Germany for the *Forges Nationale de la Chaussade* at Guérigny, France. 1000 w. 1 plate. Stahl u Eisen—Feb. 15, 1905. No. 68435 D.

Plans for Modernizing Antiquated Rolling Mills (Vorschläge zur Modernisierung Veralteter Walzwerksanlagen). Adolf Röck. A review of a previous paper by Hübers, comparing the efficiency of old and new methods and appliances. 2000 w. Stahl u Eisen—March 1, 1905. No. 68439 D.

Steel.

See Mechanical Engineering, Materials.

Steel Metallurgy.

Abstract of Lecture by Professor J. O. Arnold, University College, Sheffield, on "The Relation of Theory to Practice in Steel Metallurgy." Also discussion. 6500 w. Jour W of Scot Ir & Steel Inst—Jan., 1905. No. 68690 F.

Steel Works.

The Illinois Steel Company's Additions. Illustrated description of the new open hearth steel works and blooming and structural mills and their equipment. 1500 w. Ir Age—March 2, 1905. No. 68086.

Tube-Mills.

Tube-Mill Notes. Alfred James. Abstracted from contribution to discussion, Inst. of Min. & Met. Comments on practice and results. 800 w. Eng & Min Jour—March 16, 1905. No. 68363.

Utah.

Iron Ores in Utah. Don Maguire. Concerning the location and extent of a number of deposits which may prove of great value to the State. Ills. 1800 w. Mines & Min—March, 1905. No. 68235 C.

MINING.

Alaska.

Traveling in Alaska. J. P. Hutchins. An illustrated account, giving much information of interest to miners who have occasion to visit this region. 2000 w. Eng & Min Jour—March 16, 1905. No. 68361.

Analysis.

Grading Analyses. H. S. Denny. Abstract of a paper read before the S. African Assn. of Engrs. Explains the meaning of the term and its objects, considering methods and their results. 1700 w. Eng & Min Jour—March 9, 1905. No. 68246.

Concentration.

Concentrating Tables. Charles W. Comstock. With a discussion of the principles of concentration and their application in practice. 4000 w. Mines & Min—March, 1905. No. 68234 C.

Separating and Concentrating Complex Ores. Robert T. Clegg. Briefly reviews methods of concentration practiced, and describes the Simplex system of ore dressing, invented by Eric Hedburg. 1500 w. Min Wld—March 11, 1905. No. 68293.

Development.

The Choice of a System of Development for a Mining Property (Die Wahl eines Ausrichtungssystems beim Abbaue einer Flözgrubbe). B. Boky. A discussion of the conditions governing the choice of the method of working a mining district, with especial reference to Russian coal workings. Serial. Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 25, 1905. No. 68695 D.

Electric Power.

Application of Electricity to Mines. A. C. Anderson. Read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Remarks on the increased use of electricity in mines and its advantages, the choice of a system, voltage, generating plant, distribution, &c. 3300 w. Elec Engr, Lond—March 3, 1905. Serial. 1st part. No. 68302 A.

Special Rules for the Installation and Use of Electricity in Mines. Gives rules prepared by the Home Secretary. 4400 w. Elect'n, Lond—Feb. 24, 1905. No. 68219 A.

Tests of the Electric Light and Power Plant of the Dalbusch Mine (Untersuchung der Elektrischen Kraft und Lichtcentrale auf Zeche Dalbusch). A general description of the plant, and details of the tests of the turbo-alternator, and distribution. Two articles. 6000 w. Glückauf—Feb. 25, March 4, 1905. No. 68499 each B.

Gas Producers.

See Mech. Engng., Combustion Motors.

Hoisting.

An Underground Skip-hoisting Plant. S. A. Worcester. Brief illustrated description of plant for the Camp Bird gold mine for hoisting ore and waste from a depth of 900 ft. 500 w. Eng & Min Jour—March 2, 1905. No. 68134.

Electric Winding Engines. Aims to show that electrical winding eliminates a large source of loss. 3300 w. Prac Engr—March 17, 1905. Serial. 1st part. No. 68640 A.

Pumping.

Pumping on the Comstock. Carl George P. de Laval. Describes the installation of modern pumps to overcome the difficulties at the Comstock. Ills. 2300 w. Eng & Min Jour—March 16, 1905. No. 68367.

Roasting.

Furnaces for Blende and Pyrites Roasting. Walter Renton Ingalls. Describes furnaces used by American zinc smelters, and especially the McDougall type of furnaces for roasting pyrites, pyrrotite and chalcopyrite. 3800 w. Min Wld—March 4, 1905. No. 68199.

Shaft Lining.

The Question of Corrugated Tubbings (Zur Frage der Gewellten Tubbings). Prof. Heise. Practical data concerning the lining of shafts with metallic corrugated tubbings, showing the capacity of the system to resist pressure. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 4, 1905. No. 68696 D.

The Question of Shaft Tubbings and Methods of Strengthening Them (Zur Frage der Schachttubbings und deren Verstärkung). H. Hoffmann. An examination of the stresses upon the linings of shafts, with arrangements for reinforcement by means of ribs and clamps. 1200 w. Glückauf—March 4, 1905. No. 68692 B.

The Strength of Corrugated and Other Forms of Tubbings (Neues über die Festigkeitsverhältnisse Gewellter und anderer Tubbings). Prof. Heise. A theoretical investigation to determine the strongest form of shaft lining. 2000 w. Glückauf—March 4, 1905. No. 68693 B.

Superintending.

Mine Superintending. E. Rammelmeyer. On the duties and responsibilities of the man who directs the work in and about a mine. 1500 w. Min & Sci Pr—March 4, 1905. No. 68291.

Timbering.

Timbering at the Chillagoe Mines. T. J. Greenway. Illustrates and describes a method adopted in Queensland which permitted the use of local timber without the aid of a saw-mill. 500 w. Eng & Min Jour—March 16, 1905. No. 68365.

Veins.

Vein Structure. O. H. Howarth. Observations in regard to the manner of vein formation and the forces causing them. Ills. 3000 w. Mines & Min—March, 1905. No. 68226 C.

Ventilation.

The Ventilation of Mines. Abstracted from Appendix II. Inspection of Coal Mines Report (New Zealand), 1904. Gives formulas developed and explains their application. 1800 w. Col Guard (Sup.)—March 17, 1905. No. 68654 A.

MISCELLANY.

Antimony.

The Occurrence of Stibnite at Steamboat Springs, Nevada. Waldemar Lindgren. Believes that stibnite and pyrite were deposited by the hot waters which permeate the gravel. 1200 w. Am Inst of Min Engrs—March, 1905. No. 68562.

Emery.

Emery, Its Occurrence, Uses, &c. Herman Shultz. Notes on the scarcity of crude emery ore, the location of the deposits, the imports into the United States, its uses, &c. 1000 w. Min Wld—Feb. 25, 1905. No. 68075.

Gypsum.

Montana Gypsum Deposits. Jesse Perry Rowe. An illustrated description of these extensive deposits and their geological formations. 2700 w. Am Geol—Feb., 1905. No. 68297 D.

Quicksilver.

The Quicksilver Deposits of Huitzuco. Frank D. Pagliucci. Illustrates and describes these deposits in Mexico and their development. 600 w. Eng & Min Jour—March 2, 1905. No. 68136.

Tin.

The Assaying of Tin and Terne Drosses. George P. Maury. Brief description of the preparation of the samples, the assay, and the analysis of the button from the assay. 1300 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68570 D.

The Mount Bischoff Tin Mine. Sydney Fawns. An account of this mine in Tasmania, 3,500 ft. above sea level, the method of mining, &c. 1400 w. Eng & Min Jour—March 9, 1905. No. 68247.

Zinc.

Character of American Zinc Ores and Industry. Walter Renton Ingalls. Gives a review of the smelting practice at the various mines, describing the character of the ore. 2700 w. Min Wld—Feb. 25, 1905. No. 68074.

Notes on the Metallurgy of Zinc (Beiträge zur Metallurgie des Zinks). A discussion of methods of treating various zinc ores. Serial. Part I. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 11, 1905. No. 68697 D.

Roasting and Magnetic Separation of a Blende-Marcasite Concentrate. H. O. Hofman and H. L. Norton. Describes the ore, giving an outline of the experimental work, describing apparatus and methods of analysis, results of experiments, and conclusion. 4500 w. Am Inst of Min Engrs—March, 1905. No. 68565 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailment.

The Derailment on the Great Western Railway. A report of the Board of Trade inquiry into an accident on Oct. 4th last in Wales. 4800 w. Engr, Lond—Feb. 17, 1905. No. 68059 A.

Disaster.

The Slanelly Disaster. Editorial on Col. Yorke's report of this accident which occurred in Oct., 1904, discussing the cause. 1200 w. Engng—Feb. 24, 1905. No. 68221 A.

English Railroads.

Why English Railroads Are Safe. James Davenport Whelpley. Discusses the safeguards employed, government supervision, and the pressure of public opinion. Ills. 3700 w. World's Work—March, 1905. No. 68163 C.

Rules.

Standard-Code Rules. H. W. Forman. Discusses the need of revision of rules for single track. 3000 w. R R Gaz—Vol. XXXVIII., No. 9. Serial. 1st part. No. 68146.

MOTIVE POWER AND EQUIPMENT.

Cars.

Flat Cars for the Argentine Government Railways. Illustrates and describes the principal features of their construction. 1500 w. R R Gaz—Vol. XXXVIII., No. 9. No. 68145.

Coal Economy.

Saving Coal on Locomotives. A Saillot. Discusses how to reduce the quantity of coal burnt for the same service, giving methods used in France, and the steps taken to induce men to use it carefully. 2500 w. Ry Age—March 17, 1905. No. 68388.

Loaders.

Box-Car Loaders. William L. Affelder. Illustrated description of some of the early types and their development to those in use at the present time. 6000 w. Mines & Min—March, 1905. No. 68227 C.

Locomotive Practice.

Locomotive Practice on the New Zealand Government Railways. Charles Rous-Marten. Describes interesting features of the railway history, the conditions to be met, the early construction, types of locomotives used, their work, &c. Ills. 5700 w. Cassier's Mag—March, 1905. No. 68126 B.

Locomotives.

Chicago, Milwaukee, & St. Paul Pacific Locomotive. Illustrated description of a powerful passenger engine, with principal dimensions. 600 w. Ry Age—March 17, 1905. No. 68389.

Double End Narrow Gauge Tank Locomotive for Japan. Illustrated description with principal dimensions. 500 w. Ry Age—March 10, 1905. No. 68256.

Double Ender Tank Locomotive. Illustrates and describes a 2-6-2 engine built for the Chicago & Western Indiana. 500 w. Ry & Loc Engng—March, 1905. No. 68157 C.

High-Speed Compound Locomotives (Locomotives Compound à Grande Vitesse). Ch. Baudry. Illustrated description of four-cylinder compound express locomotives for the Paris-Lyons-Mediterranean system, with complete specifications and drawings. 3500 w. 3 plates. Rev Gen d Chem de Fer—Feb., 1905. No. 68432 G.

Locomotives for Japan. Illustrates and describes a type of narrow gauge tank engine for which an order for sixty-eight has been given by Japan to an English firm. 600 w. Engr, Lond—March 10, 1905. No. 68546 A.

Powerful "Rack and Adhesion" Locomotives for the Central South African Railway. Illustrated description of an engine for exceptionally severe gradients. 1000 w. Prac Engr—March 17, 1905. No. 68641 A.

Prairie Type Freight and Passenger Locomotives. Brief illustrated description of engines of the 2-6-2 type for the C., B. & Q. Ry. 600 w. Am Engr & R R Jour—March, 1905. No. 68132 C.

Six-Coupled Tank Locomotive for the Furness Railway. Illustrations, principal dimensions, and brief description. 600 w. Engng—March 3, 1905. No. 68310 A.

Southern Railway Six-Wheel Switching Engines. Illustration, and views and cross section with brief description. 300 w. Ry Age—March 3, 1905. No. 68200.

The Compounding of Locomotive Engines. John Riekie. Briefly considers the various types and the systems of working. 2000 w. Trans Inst of Engrs & Shipbuilders of Scot—Feb. 21, 1905. No. 68688 D.

Locomotive Testing.

Locomotive Testing Plant of the Pennsylvania at St. Louis. An illustrated detailed description. 2000 w. R R Gaz—Vol. XXXVIII., No. 10. No. 68270.

Motor-Car.

Steam-Motor Carriage for the Shappey Light Railway; S.-E. and C. R. Company. Brief illustrated description. 500 w. Engng—March 3, 1905. No. 68309 A.

Oscillations.

The Oscillations of Railway Vehicles upon their Springs (Oscillation des Véhicules de Chemin de Fer sur leurs Ressorts de Suspension). Georges Marié. Showing the importance of a rigid roadbed and great flexibility of springs, in diminishing oscillations. 1200 w. Comptes Rendus—March 6, 1905. No. 68450 D.

Train Lighting.

McElroy Automatic Axle Lighting System. Illustrates and describes this system of electric train lighting. 900 w. Ry Age—March 3, 1905. No. 68201.

The Electric Lighting of Trains (L'Eclairage Electrique des Trains). An illustrated description of the Aichele system, employing a dynamo driven from the car axle. 3500 w. Bull Tech de la Suisse Romande—Jan. 25, 1905. No. 68716 D.

The Leitner-Lucas System of Electric Train Lighting. An illustrated description of a system applied to independent single railway coaches, which is under trial in England. 1800 w. Elec Rev, Lond—March 17, 1905. Serial. 1st part. No. 68649 A.

Valves.

The High and Low Pressure Retaining Valve. Illustrated description of a device for increasing the certainty of controlling heavily loaded trains. 1200 w. R R Gaz—Vol. XXXVIII., No. 12. No. 68596.

Wheels.

The Life of Wheels and Rails. George E. Walsh. Remarks on the factors that affect the life of both wheels and rails, the types, construction, &c. 1800 w. Ry Age—March 24, 1905. No. 68674.

NEW PROJECTS.

Canada.

The Canadian Northern Railway in the West. R. D. Willson. An illustrated article, with map, describing construction work and great increase in mileage. 2000 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68376.

Extension.

The Cumberland Extension of the Western Maryland R. R. Illustrated detailed description of construction work under many difficulties, from Big Pool to Cumberland. 3500 w. Eng Rec—March 4, 1905. Serial. 1st part. No. 68181.

Western Railroad Extensions and Mining. Gives map, indicating the completed and projected transcontinental lines in the United States, Canada, and Mexico, discussing their influence on mining in the important mineral districts which they traverse. 1700 w. Min Wld—March 11, 1905. No. 68292.

Improvements.

Improvements on the Cleveland Division of the B. & O. Illustrated description of improvements to cost about $4,000,000, including straightening the line, reducing grades and changing from single to double tracks. 2200 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68369.

Improvements on the New York, New Haven & Hartford. Map, plans and description of proposed changes on this very important road, including the rebuilding of the Harlem & Port Chester as a six-track line, wholly or partially operated by electricity. 3500 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68374.

Location.

Mathematics of the Paper Location of a Railroad. J. C. L. Fish. Presents the mathematical steps involved in preparing, from the paper location of a railroad, a set of mathematically consistent alignment notes by which to run the corresponding field location. 3500 w. Eng News—March 16, 1905. No. 68336.

New Line.

The Denver, Northwestern and Pacific Ry. W. P. Hardesty. An illustrated detailed description of the construction of a new line which shortens the distance by rail between Denver and Salt Lake City, and opens new territory. 4500 w. Eng News—March 9, 1905. No. 68271.

The Denver, Northwestern & Pacific Road. Illustrated description of a line between Denver, Colo., and Salt Lake, Utah, recently completed as far as Arrowhead. 2200 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68372.

Reconstruction.

Rebuilding the O. R. & N. A fully illustrated article of work on the Oregon Railroad & Navigation lines to make a route of low grades and easy curves. 800 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68371.

Simplon.

The Northern Lines of Access to the Simplon (Per gli Accessi Nord al Sempione). N. Sacerdoti. A discussion of the railway connections on the Swiss side of the Simplon tunnel, including the Lotschberg, Stockalper, and Wildstrubel routes. 4000 w. Il Monitore Tecnico—Jan. 20, 1905. No. 68709 D.

PERMANENT WAYS AND BUILDINGS.

Line Improvements.

Line Improvements Between Indianapolis and Cincinnati, C. C. C. & St. L. R. R. George A. Stearns. Describes briefly work including reducing grades, straightening the line, replacing bridges, and double tracking, without interrupting traffic. Ills. 800 w. Eng News—March 16, 1905. No. 68337.

Metal Structures.

Iron and Steel Structures. Abstract of report presented at meeting of the Am. Main. of Way Assn. General specifications, with discussion. 22500 w. Ry Age—March 24, 1905. No. 68679.

Narrow Gauge.

Narrow - Gauge Railways (Ueber Schmalspurbahnen). H. Schwabe. An examination of the relative construction and operation costs of standard and narrow-gauge railways, with especial reference to lines in the German African colonies. 3500 w. Glasers Annalen—March 15, 1905. No. 68456 D.

Rail Wear.

The Wave-Like Wear of Rail Heads (Ueber die Wellenförmige Abnutzungerscheinung am Kopfe der Schienen). R. Scheibe. With photographs showing the nature of the wear on the rail; suggesting that the action may be due to unequal hardness caused in the rolling process. 1200 w. Glasers Annalen—March 1, 1905. No. 68453 D.

Reports.

American Railway Engineering and Maintenance of Way Association Reports. Abstracts of the reports presented to the Maintenance of Way Assn., covering a wide range of subjects. 13500 w. R R Gaz—Vol. XXXVIII., No. 12. No. 68595.

Committee Reports of the American Railway Engineering and Maintenance of Way Association. Abstracts of reports on ballasting, ties, buildings, masonry, yards and terminals, &c. 6500 w. Eng News—March 23, 1905. No. 68588.

Roadway.

Roadway. Abstract of Report at meeting of the Am. Main. of Way Assn. Gives specifications for the formation of roadbed, standard plans, &c., with discussion. 7500 w. Ry Age—March 24, 1905. No. 68678.

Shops.

Locomotive Repair Shops of the Père Marquette. Illustrated detailed description of the shops at Grand Rapids, Mich., and their equipment. 5500 w. Ry Age—March 24, 1905. No. 68676.

Running Railroad Repair Shops on the Monthly Appropriation Plan. Charles Streicher. Showing the advantages of this method. General discussion. 10000 w. Pro N Y R R Club—Feb. 17, 1905. No. 68342.

The Kingsland Shops of the Delaware, Lackawanna & Western R. R. Brief illustrated description of shops in course of construction at Kingsland, N. J. 800 w. Eng Rec—March 25, 1905. No. 68631.

Signalling.

Auxiliary Railway Signalling. Remarks on the most generally approved systems of auxiliary signalling, considering briefly some of their chief characteristics. 3700 w. Elec Engr, Lond—Feb. 24, 1903. No. 68212 A.

Improvements in Railway Safety Appliances (Neuerungen im Eisenbahnsicherungswesen). H. Scholkmann. Describing improved block signal systems, including electric, pneumatic, and liquefied gas control and operation. 5000 w. 1 plate. Glasers Annalen—Feb. 15, 1905. No. 68463 D.

Signaling and Interlocking. Abstract of report at meeting of Am. Main. of Way Assn. Considers the standard arrangement of signals, controlling, construction, &c, with discussion. 10500 w. Ry Age—March 24, 1905. No. 68680.

Standard Arrangement of Signals at Interlocking Plants. From a report of a Committee of the American Railway Engineering and Maintenance of Way Association. 2000 w. Eng News—March 23, 1905. No. 68589.

Supplying Electric Current for Interlocking Plants. C. C. Anthony. Describes a method of supplying current to interlocking switches and signals. 1800 w. R R Gaz—Vol. XXXVIII. No. 11. No. 68378.

Standardizing.

A Method for Standardizing Maintenance of Way Forces. H. W. Church. Gives statistics for summer and winter work and explains method by example and chart. 2000 w. Ry & Engng Rev—March 18, 1905. No. 68504.

Subsidence.

Coal Workings Under a Railway. Clement E. Stretton. Read before the Leicester Sec. of the Permanent Way Inst. Briefly considers the practical and the legal side of subsidence caused by mining in England. 1500 w. Col Guard—March 10, 1905. No. 68530 A.

Switzerland.

The New Lines of the Rhaeticon Railway (Les Nouvelles Lignes du Chemin de Fer Rhétique). F. Rey. Illustrating especially the Albula line from Thusis to St. Moritz, with topographical maps, profiles, and illustrations. 8000 w. Rev Gen d Chem de Fer—Feb., 1905. No. 68433 G.

Terminals.

New D. L. & W. Terminal at Hoboken. Illustrations and brief description of proposed new railroad and ferry terminal. 500 w. R R Gaz—Vol XXXVIII. No. 12. No. 68593.

New Terminal at Washington, D. C. An illustrated detailed description of the union station, the station grounds, and yard tracks, the methods of construction, &c, with a full account of the work thus far. 7400 w. Ry & Engng Rev—March 18, 1905. No. 68506.

Recent Terminal Improvements. Daniel Breck. Gives an outline of the work undertaken at the Union Station of St. Louis, during the Exposition. 7300 w. St Louis Ry Club—Feb. 10, 1905. No. 68084.

The Pennsylvania Freight Terminals in New York. An illustrated description of new arrangements for handling the enormous freight business of New York and vicinity. 3500 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68373.

Ties.

Rail Circuits and Zinc-Treated Ties. Extract from report of V. I. Smart, giving details of an interesting phenomenon caused by treating ties with zinc-chloride preservative. 600 w. R R Gaz—Vol. XXXVIII. No. 12. No. 68594.

Tracks.

Double-Track Work on the Southern Railway Between Alexandria and Orange, Va. John W. Ash. An illustrated description of the work of grading, track work, bridges and masonry. 3500 w. Eng News—March 2, 1905. No. 68109.

Track Elevation and Depression at Milwaukee. Brief illustrated account of work completed and projected. 1200 w. Eng News—March 9, 1905. No. 68282.

Track Elevation of the Chicago & Western Indiana Through the City of Chicago. An illustrated article describing the equipment, method of operation, materials, &c. 2800 w. Ry Age—March 24, 1905. No. 68671.

Trestle Timber.

Wooden Bridges and Trestles. Abstract of report presented at meeting of the Am. Main. of Way Assn. Gives specifications compiled for bridge timber, and for trestles; also paper by A. F. Robinson on "Standard Plans for Pile and Timber Trestle Bridges, Santa Fé Railway System," with discussion. Ills. 17000 w. Ry Age—March 24, 1905. No. 68677.

Yards.

The Greenville Yards and Transfer Arrangements of the Pennsylvania Railroad. Illustrated detailed description of important developments at this point, preparatory to caring for the expected increase in traffic, which includes New England business in connection with the N. Y., N. H. & H. R. R. 2000 w. Ry Age—March 24, 1905. No. 68673.

Yards and Terminals. Abstract of a report at meeting of the Main. of Way Assn. Considers especially summit and gravity yards. Short discussion. 4500 w. Ry Age—March 24, 1905. No. 68681.

TRAFFIC.

Automobiles.

Report on the Question of Traffic Conveyed by Automobiles (Subject XX for Discussion at the Seventh Session of the Railway Congress). Messrs. Keromnes, Léchelle, and E. Sartiaux. 11200 w. Ills. 1 table. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68620 F.

Cheap Service.

On the Question of the Organization of a Cheap Service on a Main Railway's Branch Lines which Carry Little Traffic and on Light Railways. Cornel de Tolnay. Subject XIV for discussion at the seventh session of the railway congress. For Austria-Hungary, Germany, and Holland. 5700 w. Ills. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68618 E.

India.

Goods Traffic on Indian Railways. Information concerning the unsatisfactory speed of India goods trains, discussing some of the causes. 1500 w. Engr, Lond—March 17, 1905. No. 68664 A.

Light Railways.

Report on the Question of the Influence of Light Railways on the Main Lines (Subject XVII for Discussion at the Seventh Session of the Railway Congress. Mr. De Burlet. 10900 w. 16 tables. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68451 G.

Pooling Locomotives.

On the Question of Pooling Locomotives (Subject VI for Discussion at the Seventh Session of the Railway Congress). E. Hubert. Report (No. 3) for Belgium, England and colonies, Holland, Denmark, Russia, Sweden and Norway. 7000 w. 1 table. Bul Int. Ry Cong—Feb., 1905. No. 68384 E.

Statistics.

Statistics of International Transport (Statistique des Transports Internationaux). Gen. A. de Wenderich. Giving forms and procedure employed for recording locomotive performance. 2000 w. Rev Gen d Chem de Fer—March, 1905. No. 68451 G.

STREET AND ELECTRIC RAILWAYS

Cable Incline.

Rebuilding of the Lauterbrunnen Grütschalp Cable Incline (Umbau der Seilbahn Lauterbrunnen Grütschalp). Siegfried Abt. The road has a grade of 55.47 per cent., with a difference of level of 670 metres between terminals. 2000 w. Schweiz Bauzeitung—March 4, 1905. No. 68497 B.

Car Equipment.

Car Lighting and Ventilation. John P. Fox. Illustrates and describes some of the methods employed on foreign roads. 800 w. St Ry Jour—March 25, 1905. No. 68624 C.

The Electrical Equipment of the New Steel Cars for the New York Subway. L. B. Stillwell. Illustrates and describes an important development in methods of wiring for electric cars. 5400 w. St Ry Jour—March 4, 1905. No. 68176 C.

Cars.

Steel Passenger Cars on the Metropolitan Elevated Ry., Chicago. Illustrated description of cars of nearly all-steel construction. The only wood used is for interior finish. 500 w. Ry & Engng Rev—March 4, 1905. No. 68165.

Car Wheels.

Car Wheels—A Study of Their Costs. D. F. Carver. Gives diagrams for determining service and scrap value of new and worn cast-iron wheels, and for comparing cost of iron and steel wheels and steel tires, and method of reasoning by which conclusions are reached. 2300 w. St Ry Jour—March 11, 1905. No. 68262 C.

Chicago Elevated.

Methods of Increasing the Capacity and Reducing the Noise Upon the Union Elevated Railroad of Chicago. Abstract of the second report of Bion J. Arnold. Ills. 3600 w. St Ry Rev—March 15, 1905. No. 68615 C.

Report upon Increasing the Capacity and Reducing the Noise of the Union Elevated Railroad of Chicago. A report on these two subjects by Bion J. Arnold is given in extract. Ills. 7300 w. St Ry Jour—March 18, 1905. No. 68393 C.

Construction.

Tramways Permanent-Way Construction and Maintenance. James Lord. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Describes methods used by the writer, illustrating apparatus. 2400 w. Elect'n, Lond—March 10, 1905. No. 68551 A.

Dynamometer Car.

An Air-Resistance Dynamometer Car. Illustrated description of the air-resistance test car "Louisiana," constructed for the use of the Electric Railway Test Commission of the Louisiana Purchase Exposition. 1700 w. Eng News—March 23, 1905. No. 68583.

Electric Traction.

On the Question of Electric Traction (Subject VIII for Discussion at the Seventh Session of the Railway Congress). W. D. Young. Report (No. 3) for America. 4400 w. 3 tables & figs. Bul Int Ry Cong—Feb., 1905. No. 68383 E.

On the Question of Electric Traction (Subject VIII for Discussion at the Seventh Session of the Railway Congress). Ernest Gerard. Report No. 2 for Great Britain and Ireland, and Belgium. 2600 w. 7 tables & Ills. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68622 E.

High Pressure.

High-Pressure Line Construction for Alternating-Current Railways. Theodore Varney. Illustrates and describes some preliminary work which has been carried out on a practical scale with overhead conductors. 2200 w. Am Inst of Elec Engrs—March, 1905. No. 68558 C.

Line Construction for High Pressure Electric Railroads. George A. Damon. Gives a brief record of what has been accomplished in line construction, and examines the requirements and difficulties of installation in order to obtain permanent insulation at reasonable cost. Ills. 3500 w. Am Inst of Elec Engrs—March, 1905. No. 68557 C.

Illinois.

McKinley Syndicate Properties of Northern Illinois. Illustrated description of the interurban line of the Illinois Valley Ry. from Ladd, Ill., to Marseilles. 2500 w. St Ry Rev—March 15, 1905. Serial. 1st part. No. 68612 C.

Interurban.

The Gerardmer-Retournemer-Honeck Tramway (Tramway de Gerardmer à Retournemer-La Schlucht-Le Honeck). A. Moutier. Description of construction material, and operation of an interurban steam railway in the Vosges near Belfort. 4000 w. 2 plates. Rev Gen d Chem de Fer—Jan., 1905. No. 68430 G.

London.

The Waterloo and City Railway.—Working Results. Herbert Jones. Abstract of a paper read before the Tram. & Lgt. Rys. Assn. Briefly describes the construction and equipment of the line, its operation, and reports 24-hour tests being made. 2800 w. Elect'n, Lond—Feb. 24, 1905. Serial. 1st part. No. 68218 A.

Waterloo and City Railway. Herbert Jones. Read before the Tram. & Lgt. Rys. Assn., London. A brief description of the plant and its equipment and the working results. 4500 w. Tram & Ry Wld—March 9, 1905. No. 68529 B.

London Underground.

The Electrification of the London Underground Electric Railways Company's System. S. B. Fortenbaugh. A full illustrated detailed description of this very interesting installation. 13500 w. St Ry Jour—March 4, 1905. No. 68175 C.

New Car.

New 4000-Type Car for Buffalo. Illustrated detailed description of new cars placed in service between Buffalo, Niagara Falls, and Lockport. 1500 w. St Ry Jour—March 25, 1905. No. 68625 C.

Paris.

The Paris Metropolitan Railway. An illustrated description of the construction of the Pasay bridge and viaduct. 2000 w. Engr, Lond—March 10, 1905. No. 68545 A.

Pavements.

Laying Street Railway Tracks in Cincinnati: Specifications for Bitulithic Pavement. J. M. Harper. Abstract of a paper read before the Ohio Eng'ng Soc. Gives a brief description of the concrete construction of a double-track railway on one of the principal crosstown lines. 2500 w. Eng News—March 2, 1905. No. 68119.

Power Houses.

See Electrical Engineering, Generating Stations.

Protective Devices.

Fuses versus Circuit Breakers for Protection of Railway Apparatus. Edward Taylor. Describes the construction of each device stating the advantages, and concludes that only by the use of both devices, conjointly, is it possible to properly protect a railway motor. 5600 w. St Ry Jour—March 25, 1905. No. 68626 C.

Railway Motors.

See Electrical Engineering, Motors.

Single-Phase.

Murnau Ober-Ammergau Single-Phase

Railway. Illustrates and describes this line which traverses a mountainous region, and has some interesting points of novelty. 1000 w. Elec Rev, Lond—March 17, 1905. No. 68651 A.

Single-Phase Car Equipment of the Indianapolis & Cincinnati Traction Company. Brief illustrated description. 1200 w. St Ry Rev—March 15, 1905. No. 68614 C.

Stray Currents.

Report on Electrolysis. E. F. Scattergood. Showing comparative effect of lead and cement joints in city water mains. 600 w. Sib Jour of Engng—March, 1905. No. 68380 C.

The Electrolytic Corrosion of Underground Metallic Pipes (Corrosions Electrolytiques des Canalisations Métalliques Souterraines). M. Nourtier. A review of the conditions under which gas, water, and other pipes are attacked by stray currents from electric tramways. 2500 w. Rev Technique—Feb. 25, 1905. No. 68-429 D.

Subway.

The New York Subway (Die New Yorker Untergrundbahn). Franz Köster. A fully illustrated account of the subway, power house and rolling stock of the New York Rapid Transit Company. Serial. Part I. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68406 D.

Testing.

Recent Work of the Electric Railway Test Commission. Especially describing the work of the dynamometer car designed and constructed for the purpose of measuring directly the head and rear pressures and the side and roof resistances of car bodies. Ills. 1600 w. St Ry Jour—March 25, 1905. No. 68623 C.

Tracks.

On Track Bonding. C. W. Ricker. Considers in detail the various kinds of bonding, and the conditions governing the material form and structure of bonds; the importance of good contacts, &c. 4400 w. Am Inst of Elec Engrs—March, 1905. No. 68556.

Track Laying on the Williamsburg Bridge. Illustrated description of methods used in laying tracks for two lines of elevated railroad, and two lines of electric street cars, aggregating about five miles in length. 2400 w. Eng Rec—March 4, 1905. No. 68190.

Tyrol.

The Stubai Valley Railway (Die Stubaitalbahn). Illustrated account of a single-phase electric railway between Innsbruck and Fulpmes, in the Tyrol, with data as to operating costs. 2000 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68468 B.

Voltage.

Feeder and Rail Drop. J. W. Welsh. Gives a method found convenient for the calculation of simple lay-outs where the number of circuits are few. Illustrates the method in a case where several feeders supply direct-current to an interurban electric road. 800 w. Elec Club Jour—March, 1905. No. 68509.

Valtellina.

Measurements on the Valtellina Railway (Messungen auf der Valtellina Bahn). M. Novi & A. Donati. Results of measurements, showing a consumption of energy of 48 watt-hours per ton-kilometer. On down grades more than 50 per cent. of the energy of the train can be returned to the line. 2000 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68469 B.

The New Electric Locomotives of the Valtellina Railway (Die Neuen Elektrischen Lokomotiven der Valtellina-Bahn). Eugen Cserhati. Full detailed description of the improved three-phase electric locomotives built by Ganz for the Valtellina line in Northern Italy. Serial. Part I. 2500 w. 1 plate. Zeitschr d Ver Deutschr Ing—March 4, 1905. No. 68407 D.

The New Electric Locomotives of the Valtellina Railway (Les Nouvelles Locomotives electriques de la Valteline). Frederic Koromzay. With full details of the mechanical and electrical construction of the new three-phase locomotives of 62 tons weight. 5000 w. 4 plates. Rev Gen d Chem de Fer—March, 1905. No. 68452 G.

The Valtellina Line and the Electrical Operation of Railroad Main Lines. Theodore Köhn. Translated from the *Organ fuer die Fortschritte des Eisenbahnwesens.* Introductory remarks with a comparison between three-phase and three-phase d.-c. operation for main lines are given in the present number. 2700 w. R R Gaz—Vol. XXXVIII. No. 9. Serial. 1st part. No. 68148.

Two Years' Work on the Valtellina Electric Railway (Chemins de Fer Electriques de la Valteline—Résultats de Deux Ans d'Exploitation). An abstract of the report of the engineers to July, 1904. 1000 w. Génie Civil—Feb. 11, 1905. No. 68412 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Ass'n. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

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THE ENGINEERING EXPORTS OF GREAT BRITAIN, GERMANY AND THE UNITED STATES.

By W. Pollard Digby.

PART I. THE TREND OF SUPREMACY, AS DISCLOSED IN THE GENERAL SITUATION.

There are certain impressive signs, especially in the vast present output of the world's most important metals—gold and iron—that we are just on the threshold of a period of industrial expansion rivaling any epoch of like character the world has ever seen. Under such conditions and expectations the question of markets—of the sources of new demand and the possibilities of new disposition of surplus production—attain unusual interest. Mr. Digby's examination of the subject is valuable particularly in that it relates to the products of engineering industry only, and to the relative standing and manifest tendency of the three great manufacturing nations. And the graphic method of presenting the results makes them immediately clear to the eye and renders comparisons remarkably easy. A following paper will take up the relative advances shown in the most important trade zones.—THE EDITORS.

THE wording of the title of this study serves to indicate to a certain extent the order of immensity of this section of the trade of the three chief manufacturing countries of the world. They are the only countries in which, according to their latest census returns, over 1,000,000 persons find employment in the preparation of iron and steel and manufactures thereof, including shipbuilding. In 1901, in the United Kingdom, 301 persons in every 10,000 of population, or an aggregate 1,249,000 employees, were so occupied. In 1900, in the United States, 152 persons per 10,000, or an aggregate of 1,151,000, were so engaged according to the census of that year. For Germany no later figures are available than those of 1895, according to which 215 per 10,000 of the population, or a total of 1,115,000, found employment in this connection. If with these figures the numbers engaged in the allied industry of mining are in each case included, the very great importance to the United Kingdom of her engineering industries becomes even more strongly marked. While, however, the output of the metalliferous mines has an important bearing on the export trade of the manufactured article, the output of coal is also of importance. Apart from that which is directly exported as fuel for bunker or other purposes, a vast amount is used in each country, a portion of which appears as an indirect export in the shape of manufactured articles. In order, however, to restrict our enquiry within a reasonable scope, fuel, mineral ores, cement, and certain other articles must be omitted. There yet remains a very formidable list which includes railway rolling stock, motor cars, electrical goods, locomotive, agricultural and other steam engines; agricultural, textile, mining, electrical, and other machinery; iron and steel in the shape of angles, bolts, rod, rails, chairs, wire, galvanized sheets, tin-plates, ingots, nails, screws, rivets, tyres, axles, wheels, and ships and their machinery.

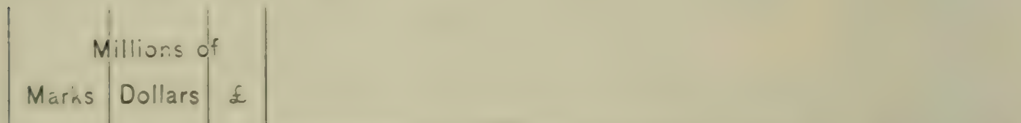

FIG. 1. TOTAL ENGINEERING EXPORTS OF THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES.

Considering, in the first instance, the total engineering export trade of the three leading engineering countries of the world, we have the following figures of the value in pounds sterling, 000's being omitted:—

Year.	1899.	1900.	1901.	1902.	1903.	1904.
	(All figures are in thousands of pounds sterling).					
United Kingdom	59,627	62,702	55,746	56,830	58,246	58,507
Germany	25,892	28,759	28,894	30,257	28,413	26,487
United States	18,743	24,383	23,464	19,711	19,827	25,711

In considering the above figures it must be remembered that the United Kingdom has the smallest population of the three countries.

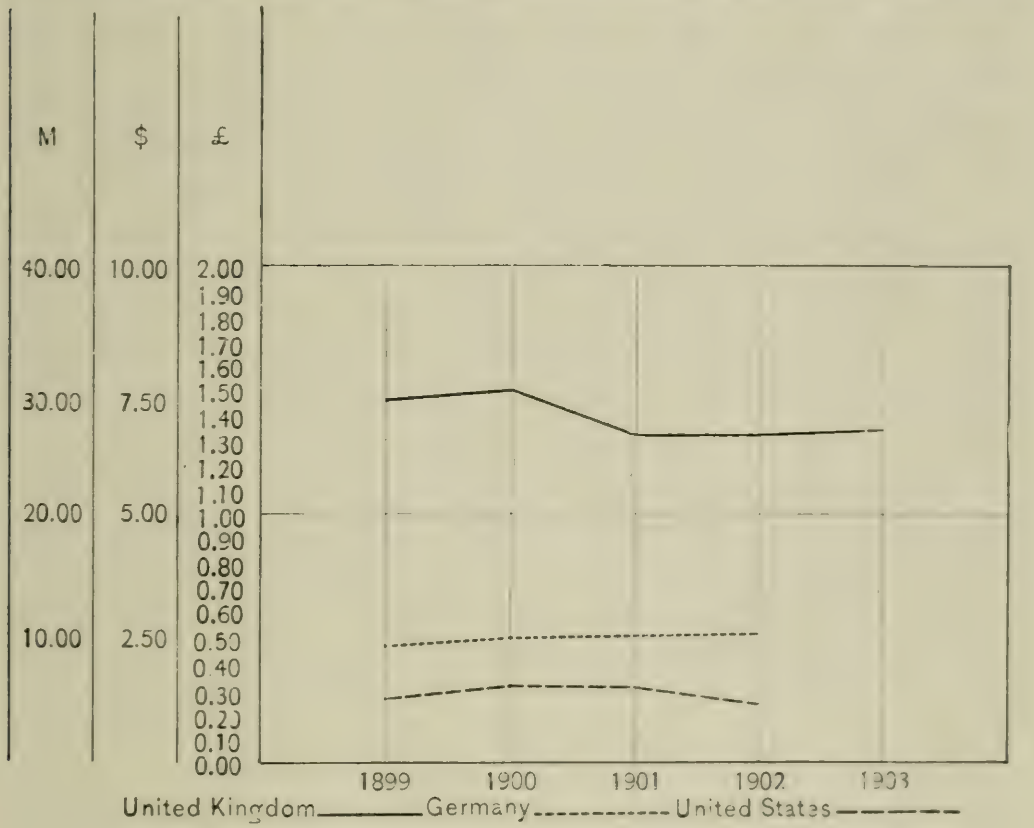

FIG. 2. VALUE OF ENGINEERING EXPORTS PER HEAD OF POPULATION.

If, therefore, we divide the above figures by the estimated population in each year, we obtain the approximate value of the engineering export trade per head of population.

Year.	£ 1899.	£ 1900.	£ 1901.	£ 1902.	£ 1903.
United Kingdom	1.46	1.52	1.34	1.34	1.37
Germany	0.47	0.51	0.51	0.52	....
United States	0.25	0.32	0.30	0.25	....

Taking for the moment 1902 only, to equal—relatively to population—the British position, the German exports would need to be increased by 250 per cent., and the American by over 530 per cent. There exists in England a somewhat large school of statistical students, who, ignoring the fluctuations which are inseparable from the course of any trade, would point to the decline from £1.52 per head of population in 1900 to £1.34 in 1902 as against the German increase of £0.51 to £0.52, as irrefutable evidence of the imminent doom of Great Britain. Few of these would dare to foretell the collapse of American engineering industrialism, because the American figures showed a fall from £0.32 to £0.25. In this case they would be quick to recognise the importance of the unascertained internal commerce of the vast area comprised within the Union. If only figures were forthcoming in Great Britain of the huge internal trade which demands engineering manufactures in such great variety, the present fiscal movement would bear a very striking resemblance to a deflated motor-car tyre. It is this ignorance of internal trade, no less than the ignorance of the conditions as to past prices and the reasons of their then inflation, which causes the so frequent selection of the early seventies as the golden era of British commerce. The sole standard with too many enquirers is that of over-sea commerce. In some cases the standard is tempered by a reference to statistics of pauperism, in regard to which there has been a continuous change of standard as to what constitutes poverty. I do not proclaim that export statistics should be ignored. Rather should they be considered intelligently as representing the means by which a country pays for a portion of its imports of food, raw material, or luxuries. According to the internal demands for food and raw materials must a country's export trade be judged. Exports can never be so vital to the United States, which is practically independent of external supplies of food, cotton, or iron ore, as to the United Kingdom which grows but little food, no cotton, and depends on imported ore for about 40 per cent. of the pig iron which is produced. The States, therefore, can only exchange their produce against manufactures or tropical luxuries, or use an excess margin of exports to extinguish national indebtedness, or employ it as a means of investment in other countries. Germany, while more agricultural than Great Britain, equally lacks raw cotton, but is relatively less dependent on food supplies. She can therefore compete in the world's markets with Great Britain on a rather formidable scale for raw wool, raw cotton, and even for iron ore. On the other hand, with less wealth invested abroad, a greater proportion of German imports represent the result of barter than is the case for Britain, a portion of whose imports are the interest of foreign investments.

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* It must be remembered that the United States fiscal year ends June 30, while the British and German fiscal years each end on December 31. All American figures quoted refer to the American fiscal year.

A disquisition, however, on the elements of political economy would be out of place; I must therefore leave this aspect of the question for a consideration of the relative positions occupied in the neutral markets of the world by the three arch manufacturing countries. Before commencing to review, a last comparison may be made between the United Kingdom and the United States by a computation of the value of the engineering exports per head of population employed in the parallel industries.

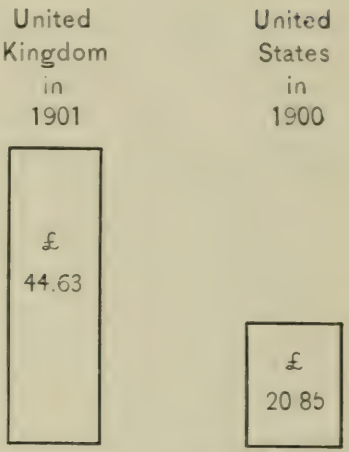

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FIG. 3. VALUE OF ENGINEERING EXPORTS PER WORKER ENGAGED IN ENGINEERING INDUSTRIES.

As the latest German figures of population employed in engineering only apply to 1895, a year outside the scope of our immediate enquiry, there is no reason for their present inclusion.

United Kingdom (1901), £ value per head of engineering population....	44.63
United States (1900), do. do. do.	20.85

PART II. INTERCHANGES OF ENGINEERING MANUFACTURES BETWEEN THE THREE COUNTRIES.

United Kingdom.—Inasmuch as a considerable amount of the export trade of these countries is done with one another, it becomes necessary to consider for each in turn the market which it offers to the other's goods. The following are the total figures for the United Kingdom collected from the detailed trade returns issued by the Board of Trade:—

Year.	1899.	1900.	1901.	1902.	1903.
Imports, ex	In thousands of pounds sterling.				
Germany	1,115	1,340	1,603	1,638	1,287
United States	4,093	3,781	3,614	3,809	3,130
Total........................	5,208	5,121	5,217	5,447	4,417

From Germany the exports have consisted chiefly of machinery and of several articles in a semi-finished condition, such as plates, bars, angles, etc. There is very little doubt that in the four years mentioned a considerable proportion of German iron and steel has entered Great Britain via Belgium or Holland. This question of competing routes, by which it may happen that the country from which goods are imported is not the country of actual origin, has received the consideration of the officials of the Board of Trade, with the result that among the information given in the second "Enquiry Blue Book" of 1904, is that of the relative value of the imports into the United Kingdom during the first six months of 1904,

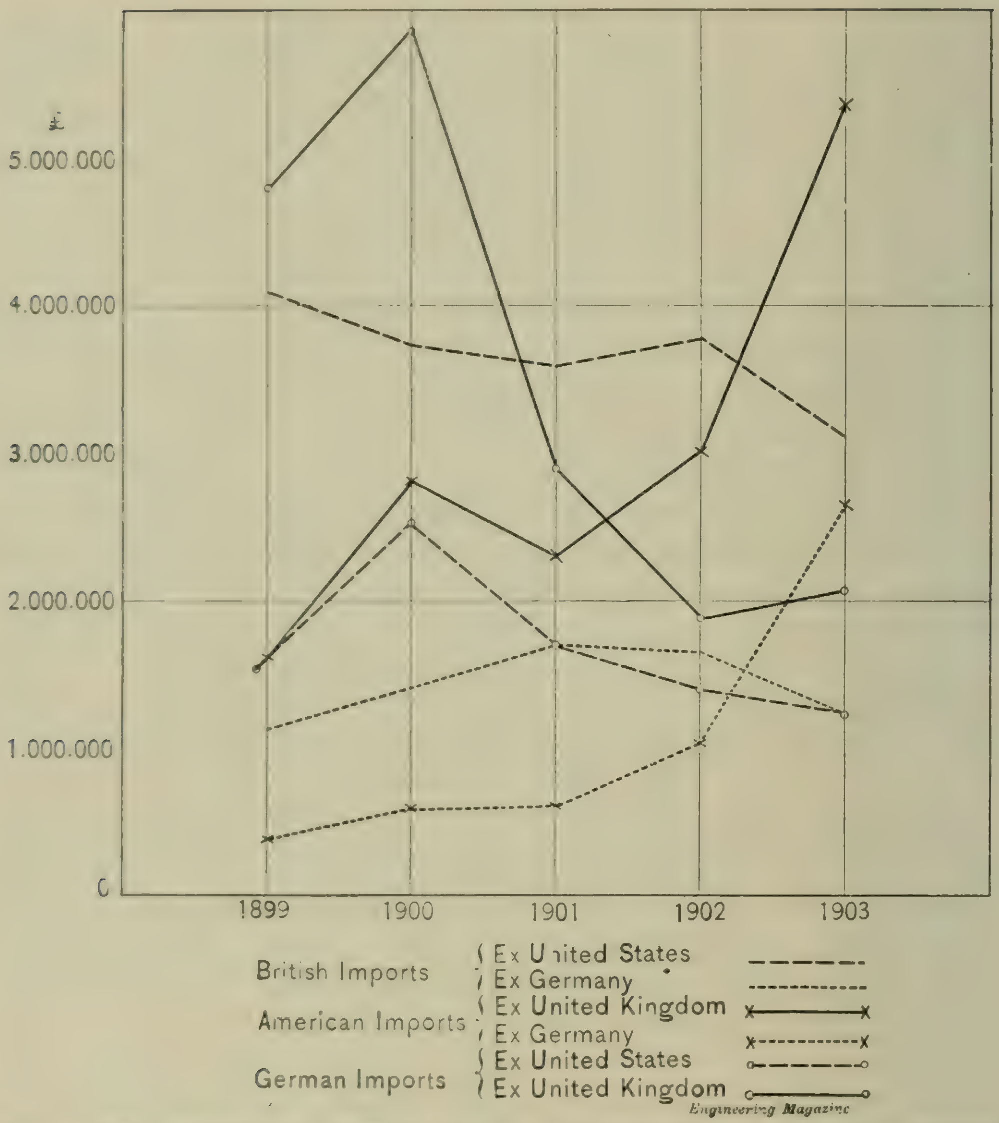

FIG. 4. TOTAL VALUE OF INTERCHANGE OF ENGINEERING COMMODITIES BETWEEN THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES.

distinguishing the value received from, and the value consigned to, each country. Thus, of the imports from Germany which amounted to 23½ millions sterling, only 13⅓ millions' worth came direct from Germany, while goods worth 10 millions sterling came via Holland and Belgium. It is absolutely impossible to apply any correction on this account to the foregoing table, while the inclusion of the imports from Holland and Belgium would only serve to furnish an unsatisfactory and exaggerated estimate, as the latter country at any rate possesses large engineering industries of its own.

With regard to the imports of engineering manufactures into the British market, it must also be remembered that part are directly re-exported in the condition in which they arrived, by reason of the exceptional position which Great Britain occupies as an entrepot of the world's produce, through its present fiscal position and splendid shipping supremacy. Part also of the imports, being in a semi-manufactured condition, are worked up into a more highly finished form and re-exported in that state. In all the figures given in the succeeding pages of British exports, direct re-exports are excluded, only those returned as of British or Irish manufacture being enumerated.

Germany.—Just as the United Kingdom affords a market for certain goods of engineering utility of German or American origin, so also Germany imports goods coming under this category from the two other countries. The following figures are taken from the German returns. They do not agree exactly with the export figures in the British returns. This is due to alterations and differences in classification:

Year.	1899.	1900.	1901.	1902.	1903.
Imports, ex	In thousands of pounds sterling.				
Great Britain and Ireland.........	4,713	5,812	2,835	1,879	2,169
United States	1,604	2,499	1,639	1,216	1,098
Total......................	6,317	8,311	4,474	3,095	3,267

Compared with the British figures given earlier in this section, the German figures show wide fluctuations. Whereas the difference between any two succeeding years of the period under review of the British engineering imports from Germany and the States does not greatly exceed 2 per cent., the German figures show that during the depression of 1901-1902, the variation between 1900 and 1901 was about 45 per cent., and nearly 30 per cent. between 1901 and 1902. Yet Britain has been called the dumping ground of the world, and woeful pictures are being continually paraded of the imminent downfall of British trade because of the manner in which the "protected" Yankee or Teuton undersells her manufacturers. Of the comparative hold of England and the States on the German market, it will be seen about two-thirds of the goods now come from the former country, while compared with 1900, the "boom" year, the greatest relative retrogression has been British. The above table is based on abstracts in parts 11 and 20 of the "Auswartiger Handel des Deutschen Zollgebiets im Jahre 1903," a publication to which repeated reference will be made in the succeeding pages. The import figures quoted are the sum of the "Spezialhandel" or "Special Trade," which includes goods imported for use or consumption at home, materials and components imported in order to be made up in the country and then exported, together with duty-free goods which, having been imported, will be sold for export without change of form. These special goods are imported under the two main groups of (6) iron and iron wares, and of (15) instruments (i. e., tools), machinery, and ships. Of specific items from the United States, there has been a marked decline of metal-working machines, while typewriters have increased, sewing machines only slightly receding. The British retrogression has been mainly in regard to iron and steel wares, and (slightly) in regard to machinery.

United States.—With regard to oversea commerce proximity is often an important factor, yet distance does not so materially affect the inter-commercial relations between the United States on the one side and England and Germany on the other as might be supposed, as in addition to supplying England and Germany with certain articles, the United States make considerable purchases of tin plates, cutlery, and machinery from these countries. The following are the total figures:—

Year.	1899.	1900.	1901.	1902.	1903.
Imports, ex	In thousands of pounds sterling.				
United Kingdom	1,507	2,821	2,282	3,064	5,201
Germany	333	564	609	1,054	2,674

The dominant factor in the imports from Great Britain have been those of the "ruined" tin-plate industry; indeed, the rise in this connection between 1901 and 1902 accounted for more than half of the increase. Large imports of wire rods, pig iron, and ingots also came from Great Britain; general increases under these heads counterbalancing a loss between 1901-1902 of £100,000 in the value of British machinery. The year 1903 was marked by extensive pig-iron imports. In 1903 the imports of tin plates fell, but the imports of British machinery rose in value. The German increase throughout this period is due to a rise in exports of steel ingots, bars, blooms, etc., and in the cutlery and machinery trade. It may be mentioned in passing that in 1902 while $5,995,515 worth of tin plates came from the United Kingdom, $147 worth came from Germany. The general trends of American imports under certain specified headings are shewn in Diagram No. 5.

PART III. THE RELATIVE HOLD OF SPECIFIC ENGINEERING MARKETS.

Continental Europe (Excluding Germany).—At the outset, it must be conceded that questions both of geographic position and of community of language between buyer and seller are important factors in determining the export trade from any country to any particular country, or to the group of countries comprised in any trade

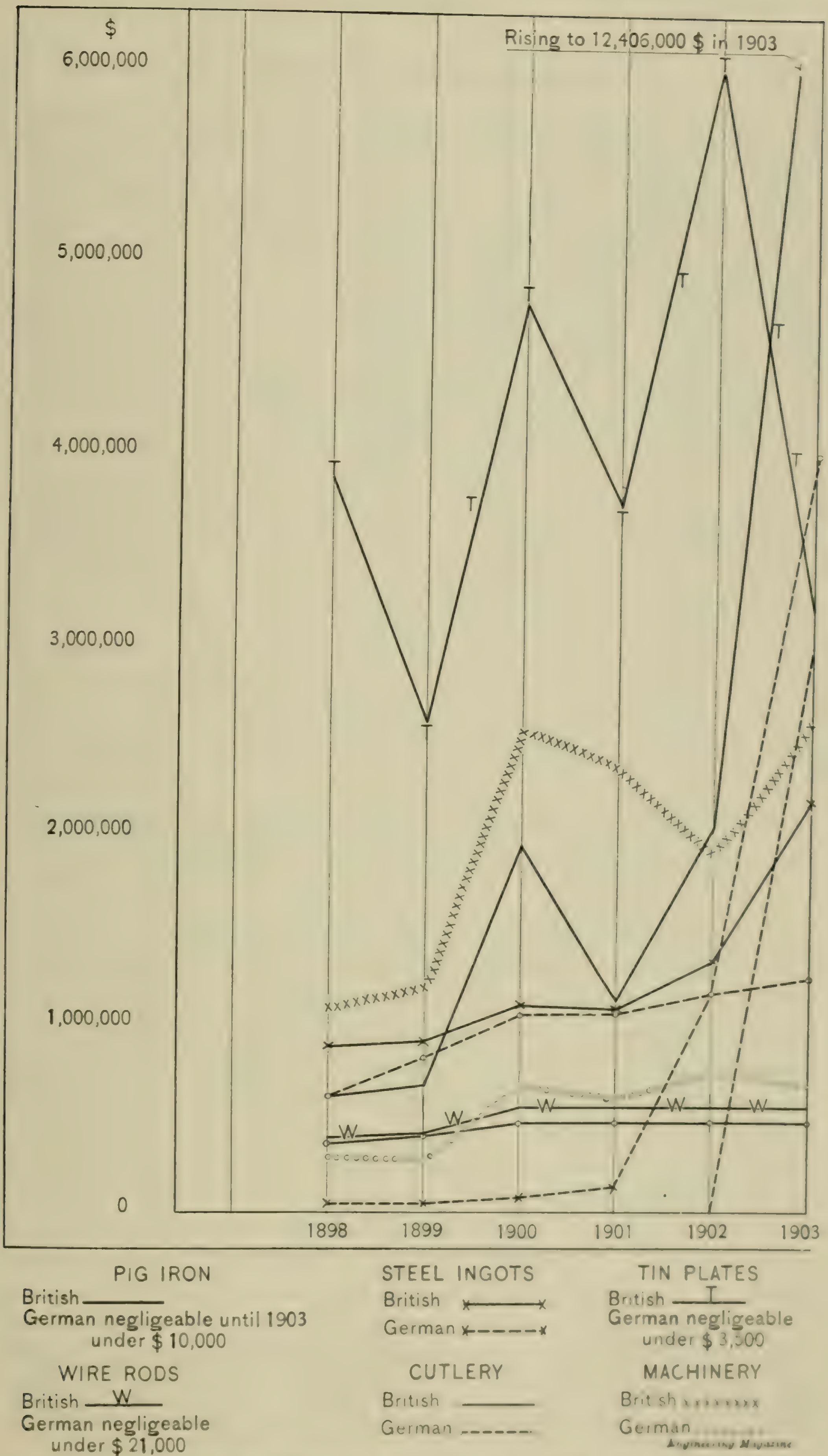

FIG. 5. COURSE OF CHIEF AMERICAN ENGINEERING IMPORTS FROM THE UNITED KINGDOM AND GERMANY.

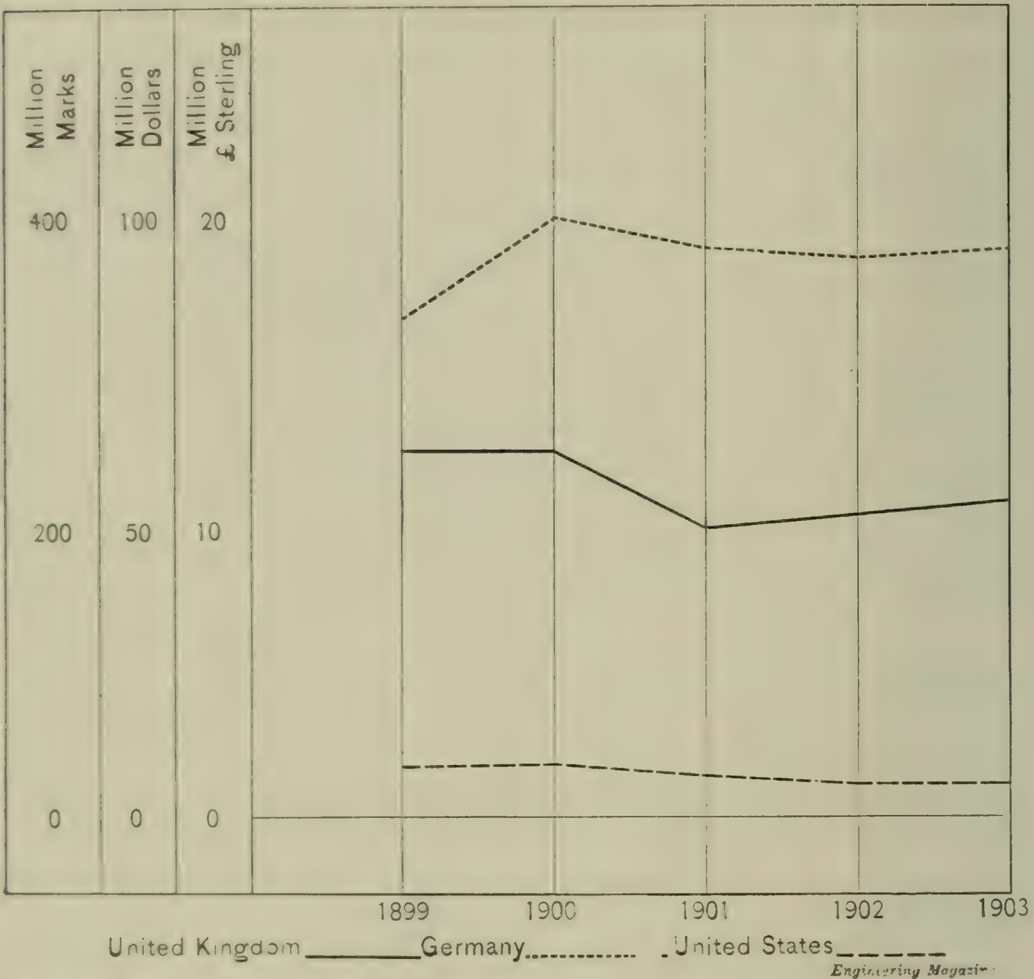

FIG. 6. TOTAL ENGINEERING EXPORTS OF THE UNITED KINGDOM, GERMANY, AND THE UNITED STATES TO EIGHT EUROPEAN COUNTRIES.

zone. Very much of the recent success of the German trader in the world's neutral markets is due to his recognition of this fact. Partly by his linguistic accomplishments, the German is securing in the English-speaking world a trade in many ways superior to that which the Briton is retaining in the non-English speaking world. Situated in the centre of Continental Europe, Germany is also at a great advantage geographically as compared with the steel manufacturer of Middlesbrough or Pittsburg. The element of time, both in obtaining tenders and securing delivery, is wholly to the advantage of Germany in any competition with the United States, but is not so greatly so in the case of competition with Great Britain.

To enumerate the trade of every small State is not essential to a sufficiently accurate survey of the general trends of trade in the European market. It suffices, therefore, to compute the total volume of the trade in each case between the three manufacturing countries, and Belgium, Italy, Russia, France, Holland, Spain, Portugal, and Austria-Hungary, and to regard this as a fair index to the relative hold on the European market retained by these countries.

EXPORTS TO EIGHT EUROPEAN COUNTRIES.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	14,016	14,167	9,666	10,330	10,691
Germany	16,307	19,680	18,633	18,432	18,866
United States	2,134	2,390	2,033	1,789	1,971

This particular group of countries is notable on account of the position held by the German Empire. In 1899, 50 per cent. of the

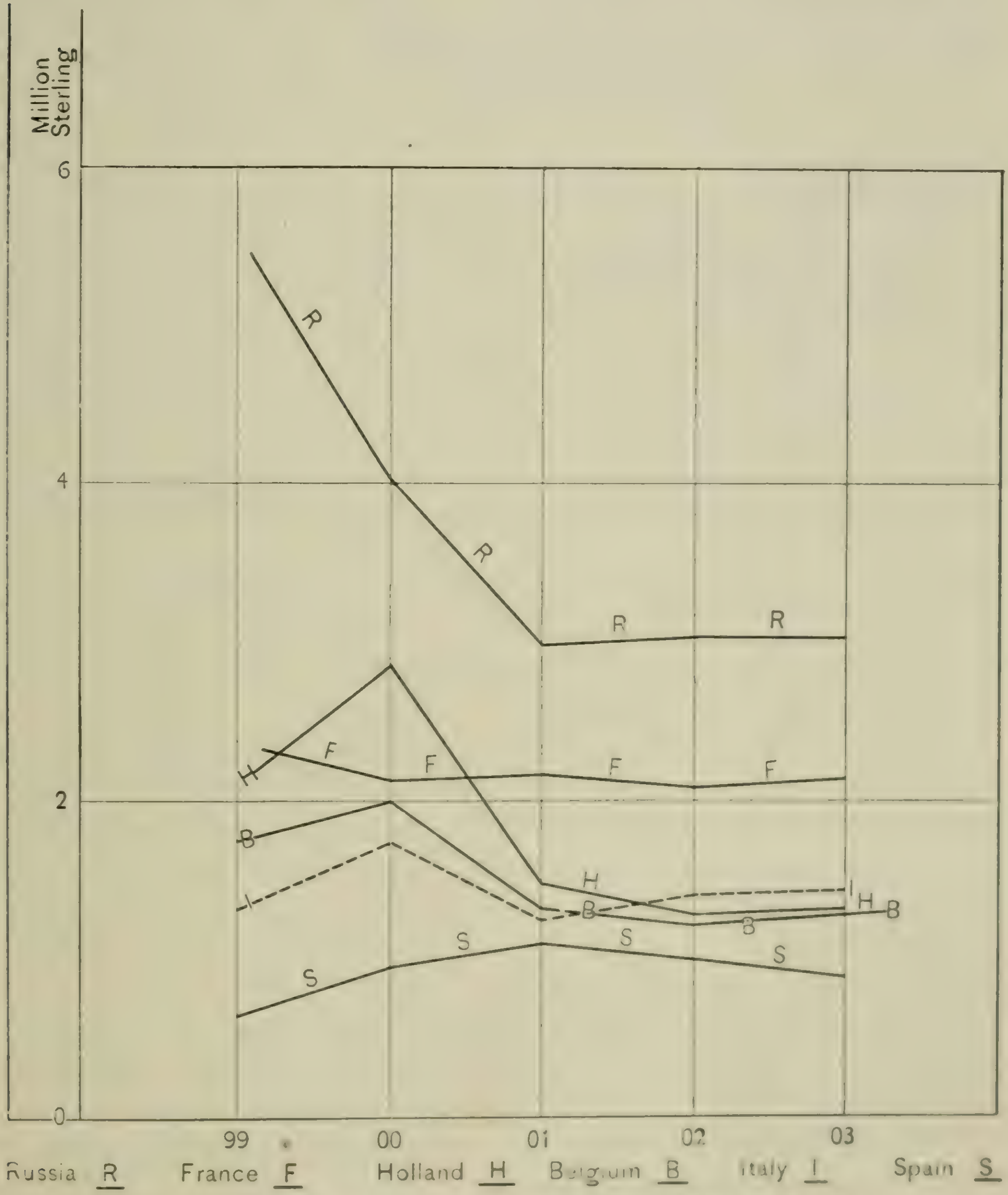

FIG. 7. BRITISH EXPORTS TO LEADING EUROPEAN COUNTRIES.

engineering trade was German; in 1902, owing to the large British (and small, American) declines, the percentage was nearer 64. The American hold on this market is a slight one, and reached its maximum in 1900—the year of phenomenal activity. This group of eight European countries enumerated above forms the chief German market, receiving in 1900 nearly 68 per cent. of the German engineering exports, 9 per cent. of the American, and barely 23 per cent. of the British exports. These figures are illustrated in Diagram No. 6. The British decline since 1899 and 1900 has not been confined to any particular country, although it has been most marked in the case of Russia, Belgium, and Holland. Of individual items, the tin-plate exports have increased in nearly each year to each country; this advance has been outweighed by the decline in the exports of ma-

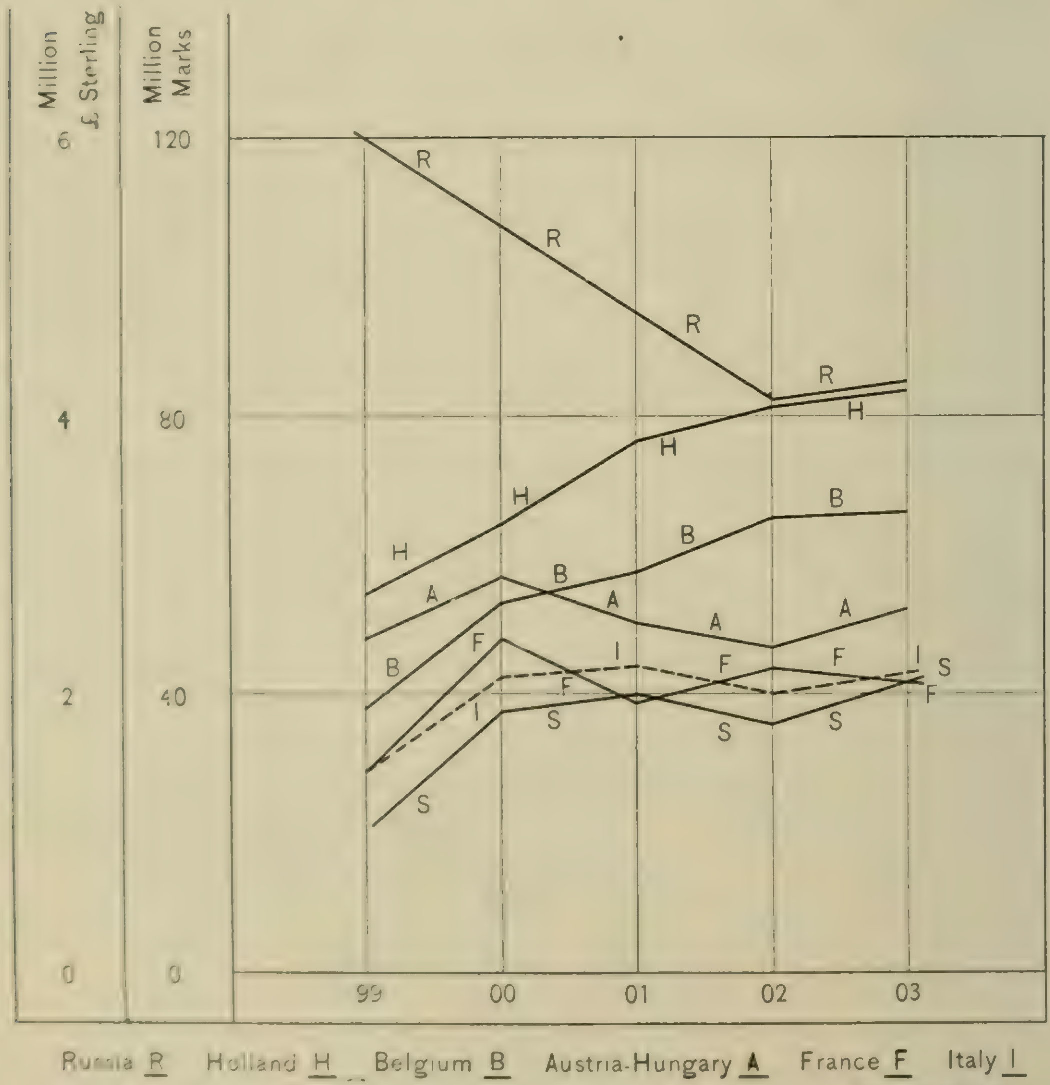

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FIG. 8. GERMAN ENGINEERING EXPORTS TO LEADING EUROPEAN COUNTRIES.

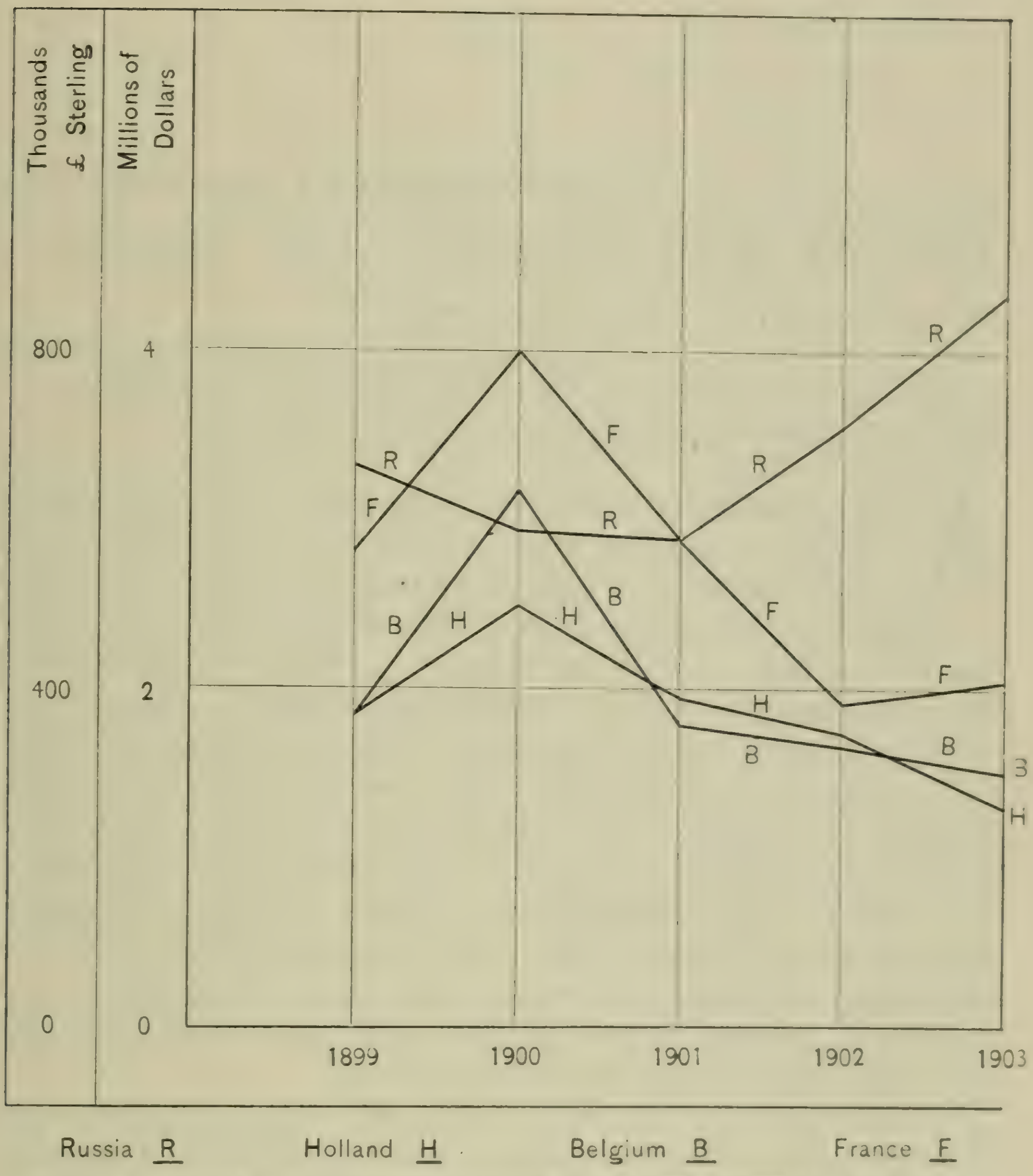


FIG. 9. AMERICAN ENGINEERING EXPORTS TO LEADING EUROPEAN COUNTRIES.

chinery and mill work, and in iron and steel wares generally. Diagram No. 7 gives the fluctuations of the total British exports to the chief countries. The German trade has been fairly uniform to each of the countries, save that there has been a marked decline in the trade to Russia, and save also the exports to Holland and Belgium.

As regards the American exports of engineering goods to Continental Europe, curves are given on Diagram No. 9 for only four countries. Save for Russia, there have been declines in the case of the exports to France, Holland and Belgium. The American trade to the other countries of this zone is relatively negligible.

To be continued.

ROLL TURNING: AN IMPORTANT MECHANICAL FEATURE IN THE IRON AND STEEL INDUSTRY.

By W. S. Standiford.

The department of engineering industry discussed by Mr. Standiford occupies an interesting field lying within the joint province of mechanical and metallurgical engineering. It exhibits a development in which the machine-tool builder—who owes so much to the iron and steel maker—has repaid an important part of his debt.—The Editors.

AMONG all the various trades in the world, that of roll turning occupies a position which is important and unique. It is an occupation that is little known except by those who work in rolling mills, and the average person generally has a very hazy idea of the trade. I once asked a man: "What is a roll turner?" The answer received was: "A roll turner is a baker." This man evidently had bakers' rolls on the brain. Some other people think that a roll turner is a machinist; this also is a wide mistake, as the trades are separate and distinct, the lathe and tools used in the one working in an entirely different manner from that characteristic of the other. As a general rule, machinists know nothing about roll turning; of course there are some who have taken advantage of an opportunity and learned the trade, but there are very few of them, as the rank and file of journeymen are recruited from apprentices who have served their four years time at turning rolls.

The influence that this trade has on the progress and civilization of the world is most remarkable as well as beneficial. Before the era of rolling iron and steel beams, rails, etc., came into use, the usual method was to forge or cast them. This was a slow and uncertain way, and produced articles far inferior in strength and appearance to the rolled ones; the output also was limited. The reason why the cast is inferior to the rolled section is that rolling gives a fibrous and more homogenous structure which resists strains better. The rapidity with which various shapes and sections of steel can be rolled, as well as the excellent quality and cheapness per ton secured, has given to the world an engineering material that is unsurpassed for building bridges, steamships, and machinery, and the cheapness of its production is due largely to the improvements in roll turning and rolling. Much of the comfort and safety in traveling, and many of the luxuries we enjoy nowadays, are due to the roll-turner's art, and it is the foundation of the iron, steel, copper and brass industries.

Roll turning was invented in 1784 by Henry Cort, and ever since then the trade has been developed by various roll turners and mechanical engineers, each one having added his mite, until we have in our modern reversing and continuous mills machinery that is capable of turning out an enormous tonnage of iron and steel with very few men employed to handle the mills; this produces large profits with small expenses, and also a first-class product. The majority of rolling mills in the United States, however, are small ones, capable of turning out an output of 15 tons per turn and upwards. They are gradually giving place to modern equipment, and there is no doubt but that in the future the small industrial plants will be equipped with up-to-date machinery. The rivalry for commercial supremacy will finally bring about this result. It is a case of survival of the fittest.

While the science of roll turning has advanced very rapidly, yet curiously enough, there have been very few improvements in the lathe by which the roll turner produces such excellent results. Such as have been made relate to minor details, such as adjustments to permit the topping of rolls quickly, the fastening of the tool rest, the tailstock, the shape of housings, and a few other devices. But the fundamental principle of working remains the same, and always will despite the march of progress in other directions.

The roll lathe is a machine of extreme simplicity, and the turning tools are of such a character, and the methods of working them are such, as are found in no other lathe. The machine is built in various sizes, to take in different classes of work. It consists of a long and wide bed, hollow in the middle to hold the turnings, technically called "swarth." The necessary gearing and pulleys to drive the machine are located at one end of the bed. In modern mills the lathe is directly connected by gearing to an electric motor, thus doing away with belting. Revolving on a hollow shaft connected with the gearing, and placed at a right angle to the bed, is a heavy wheel 4 feet or more in diameter, called the "face plate," which has bolted onto the side, in the middle, a square shaped box with fluted insides. Projecting outside the box is a square piece of iron about 18 inches long, with fluted sides; this is called a "spindle." Over this spindle is placed a round iron box about 8 inches long, and fluted inside; this is made of sufficient size to slide freely on the spindle. This arrangement is used to drive the roll when it is in the lathe.

All rolls are made with a journal or neck on each end, and also fluted wobblers on the extreme ends of the roll. The wobblers are of such a size that the round box on the end of spindle is placed half way on the latter, and half way on the roll. This makes a very flexible driver. Placed across the bed of the lathe are two cast-iron devices called "housings." There are square depressions in the middle of each housing, each containing an iron block with the upper end hollowed out and lined with babbit. These form the bearings for the necks of the roll to revolve in. The bearings are so arranged as to have some end play, this being secured by set screws on the housing. The back ends of the latter usually have small blocks of iron to form the back bearings. The top bearings or caps are formed of long rectangular pieces of cast iron having a circular depression in the middle, and each having a round hole of sufficient size to go over the back ends of the housings, and down it. The front ends of the caps have inverted U-shaped slots. Through these extend long iron rods each threaded on the upper end and carrying a nut and washer. The lower ends of the rods are slotted and are held in place by keys.

The back ends of the housing where the caps go over it contain a rectangular slot, and also a removable key which, with the aid of the threaded front rod with its washer and nuts, keep the top bearings or caps pressing down on the roll. The latter is put into the lathe, and so adjusted that there is ¼-inch clearance between the driving spindle and the wobbler on the roll, the spindle being turned around until the flutes in it are opposite the flutes in the roll wobbler, and the box being pushed half-way onto the wobbler.

The caps are then placed on the necks of the roll, the keys put in the back ends and the nuts on the front rods tightened. The set screws that operate the bottom bearings are then screwed up to prevent end play of the roll; the back bearings also are pressed against the necks by the screws in the back of the housings. Across the front ends of the housings is placed a long rectangular casting containing two inverted T-shaped slots, one at the front end and the other at the back. It also has numerous square holes, extending from top to bottom. It is held from sliding endwise by lugs cast on the bottom, with set screws through it pressing against the housings. The front ends of the latter are also provided with set screws to hold it in place. In the slot next to the roll is placed the tool carriage, a rectangular forging with flanges on the bottom of sufficient size to allow it to slide freely in the slot. On the front slot is located the pusher, which is a solid piece of iron, with a flange on the bottom and having a long set screw. This is used to feed the tool into the roll.

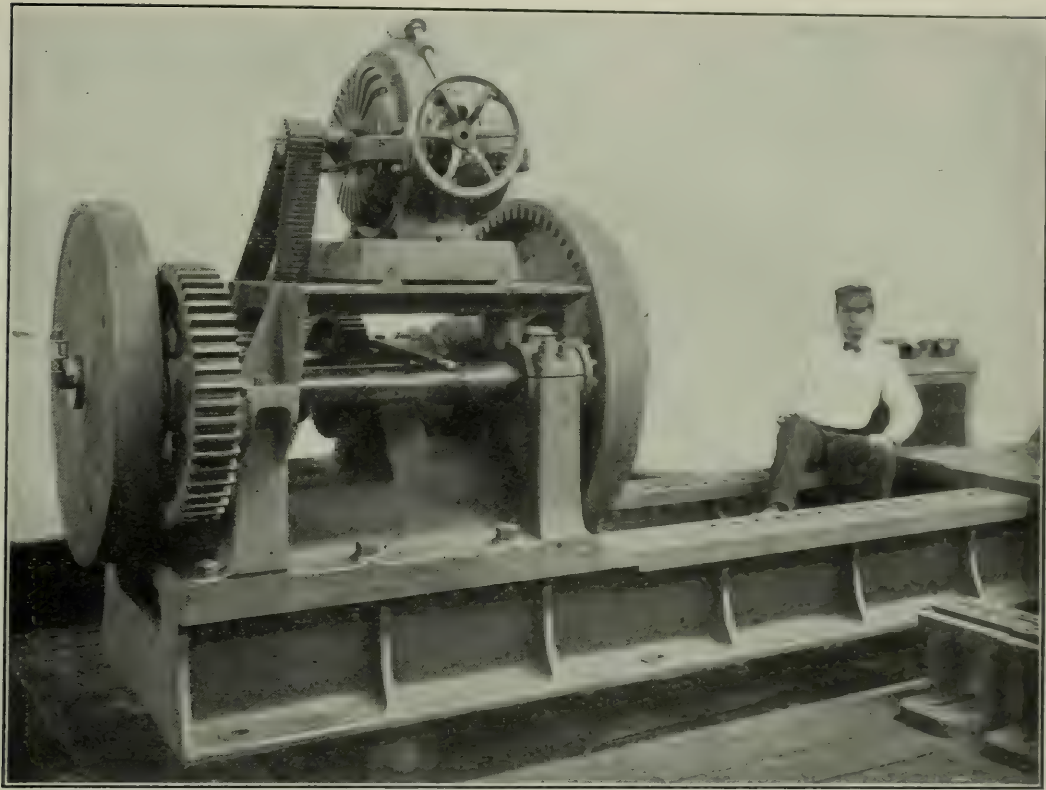
There is considerable difference between roll-lathe tools and machinist tools, their shape and methods of working being entirely different. In order to show this clearly, we will suppose that a groove is to be turned in a roll for making bar iron. The tool consists of a piece of hardened steel 1¼ inches thick, 12 inches long, the width depending upon the size of groove wanted; in this case it will be 4 inches wide. The front end is ground to a straight edge; the right and left sides of the tool are ground a few degrees off a right angle, so as to leave the groove with a slight taper for clearance. The bottom and sides of the tool also are tapered so as to clear the roll, leaving the top edges to do the cutting. It is placed in the tool carriage, a small flat piece of iron called "packing" placed on it, and an iron wedge driven in to hold it in place. A post containing a set screw is then put in one of the square holes in the rest opposite the front of the tool, another post being placed on the other side near the rear end. The pusher is then placed in position back of the tool; the lathe is started up, the wrench on pusher is turned until the tool begins to cut, and given a turn every revolution of the roll to keep the tool cutting. Should the roll be calipered at this juncture, it will usually be found that the cut is not going down straight, one part of the roll being cut deeper than the other. This is remedied by giving the shank a light tap with the hammer or else pressing the shank over by tightening the set screws in the side posts.

In managing the tool and handling the calipers there is considerable difference between the roll turner and machinist. The latter, in beginning new work, sets his calipers a little larger than the finished size that is wanted, and feeds the tool (attached to the slide rest) into the work by hand, calipering with the set-spring calipers until he has the desired size. Then he connects his slide rest with the lead screw and the tool is then dragged sideways along the work, cutting on the side and point. The V's on the lathe and carriage ensure that the work is turned straight. Work turned on a machinist lathe is always slightly out of true circular form, no matter how fine the feed is. This is due to the cut being dragged sideways before it runs out.

The machinist when sizing work with his calipers generally has a heavier touch than a roll turner. The latter handles his calipers so as just to feel the work; this is called a "feather" touch and is essential to good roll turning. In order to keep the cut going straight, the groove has to be calipered often. When it is within 1/32 inch of the finished size wanted, the workman takes out the roughing tool and puts in the finishing one, which is very sharp; he takes a light cut and allows it to run out, when the groove will be found to be accurately round.

In turning the necks or journals for rolls, the housings, rest, and driving box and spindle are removed from the lathe. A center is put in the hole in the face-plate shaft, the tailstock containing the other center is put in place on the bed of the lathe, and bolted down. The roll is centered and bored with holes in the ends of the wobblers to match the angle of the lathe centers. A driving dog is slipped over the end of one wobbler, its bent ends pressing against lugs cast in relief on the face plate. This drives the roll when it is on the centers. The tool rest for necking is a casting about 2 feet wide, having the usual slots and holes on its top, as previously described. The rest is of sufficient length to go across the bed, the height being such as to allow the tool to be one inch below the center, which gives better cutting power to it. A machinist tool is usually set to cut on the center or above it. Roll-turners' tools will not cut above the center nor if placed on the exact center, but always have to be placed below. The power required for roll lathes varies with the width and angle of tool used, the weight of the roll and the material turned (as for example sand chilled and steel rolls) and also with the heaviness of cut. Using a 3½-inch wide tool and taking a heavy roughing cut on a steel roll, 7½ horse power is required to turn the lathe. Taking a finishing cut with the same sized tool, and on the same roll, 3½ horse power was needed. These results were taken from actual tests and are gotten by electrical measurements, the lathe being driven by an electric motor of 15 horse power. Heavier cuts can be taken on sand than on steel rolls. This is due partly to the tougher nature of steel, and also to the "drawing-in" action which it exerts on a tool when a steel roll is being turned. When a heavy cut is taken, the roll continues to draw the tool in, until the latter has over-reached its maximum cutting capacity; then the weight of the roll comes on the tool, bending the prop under it and breaking the tool. For this reason it is advisable not to take too heavy cuts in working steel.

It must be understood that the above mentioned width is not the widest tool that can be used on roll lathes, various sizes being used. The width of the tool used depends also on the power supplied, some belt-driven lathes having all they can do to pull a cut 6 inches wide. Steel for roll-turning tools should be very high in carbon, 1.50 per cent. making fine tools. This, however, must be heated carefully by the blacksmith, so as to avoid burning; a cherry red is the highest that

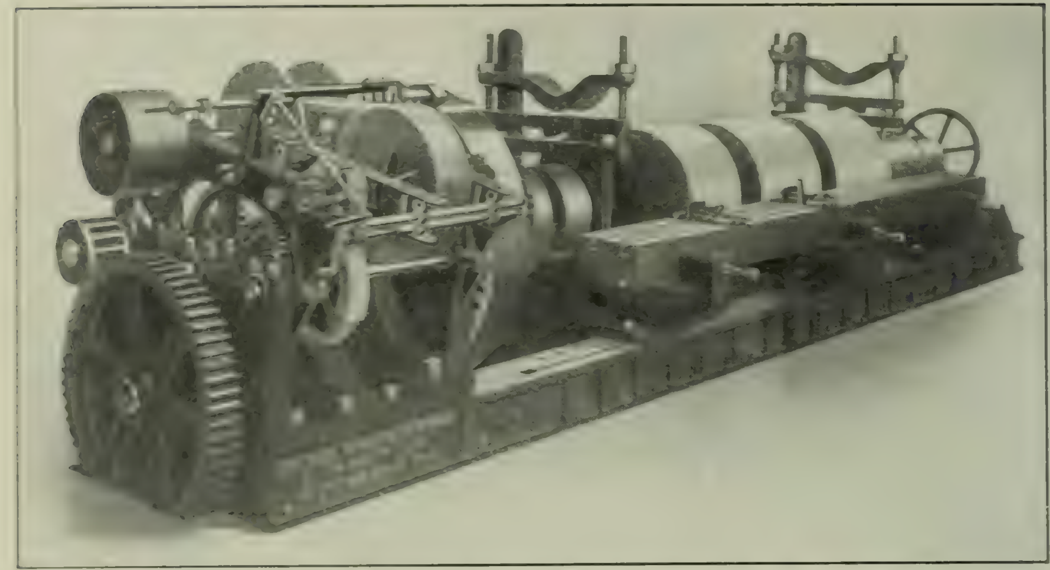


ROLL LATHE DRIVEN BY VARIABLE-SPEED MOTOR.

Made in sizes suitable for turning rolls 26, 31, 40, and 50 in. over necking rest; speed can be changed without stopping the roll, simply by turning the hand wheel.
A. Garrison Foundry Co., Pittsburg.

it will stand. When rightly heated and hardened it gives fine service, and takes a good sharp edge.

High-speed steel has not been tried yet for roll turning to any extent, on account of its price; but it would seem that there is a brilliant future ahead for steels containing 4 per cent. of nickel and also 5 per cent. of chromium. It is a well-known fact that all tools must be harder and tougher than the material they are turning in order to do cutting. When they are nearly matched for hardness, the tool has to be ground very often, thus delaying the work, and adding to the expense. Very few employers seem to realize this, thinking that "any old thing will do," and buying cheap steel. The hardest materials the roll turner has to turn are chilled iron rolls, these being nearly as hard as the tool used to turn them, and nowhere does poor steel show to such a disadvantage as in turning this class of rolls. Low-grade steel when used on chill rolls loses its edge rapidly, and when used for finishing a groove, the edge also breaks out and makes fine hair-like lines on the finished work. It does not produce truly circular work on account of its being unable to keep a sharp cutting



60-INCH ROLL LATHE WITH VARIABLE-SPEED COUNTERSHAFT ON THE HEADSTOCK, TURNING A 42 BY 152-INCH PLATE ROLL.

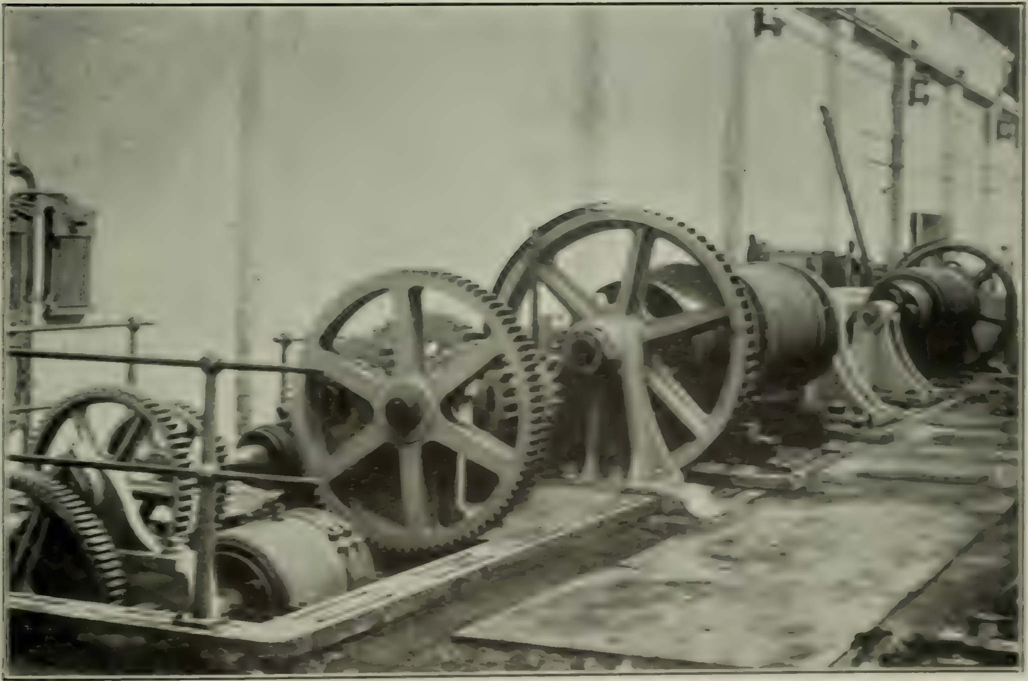
Bed 30 ft. by 5 ft. 7½ in.; 20 in. high; 19 ft. between centers; length of piano rest 15 ft.; of necking rest 36 in.; gear ratio 271 to 1; weight 90,000 lb.; two 12-in. tools can be operated on one plain-face roll at one time. United Engineering & Foundry Co., Pittsburg, Pa.

edge, it being necessary to use very sharp tools in finishing work. Nickel steel possesses great toughness and hardness, being about 45 per cent. tougher than the best grades of tool steel sold in the market. High-carbon nickel steel would make most admirable tools for chill work, on account of having the above mentioned qualities.

There are two stages in roll turning, one called "turning" and the other "dressing." Turning is the making of new rolls out of the rough castings as they are received from the foundry; new ones do not have to be turned every day in ordinary sized mills, although in large ones they always keep some journeymen on new work.

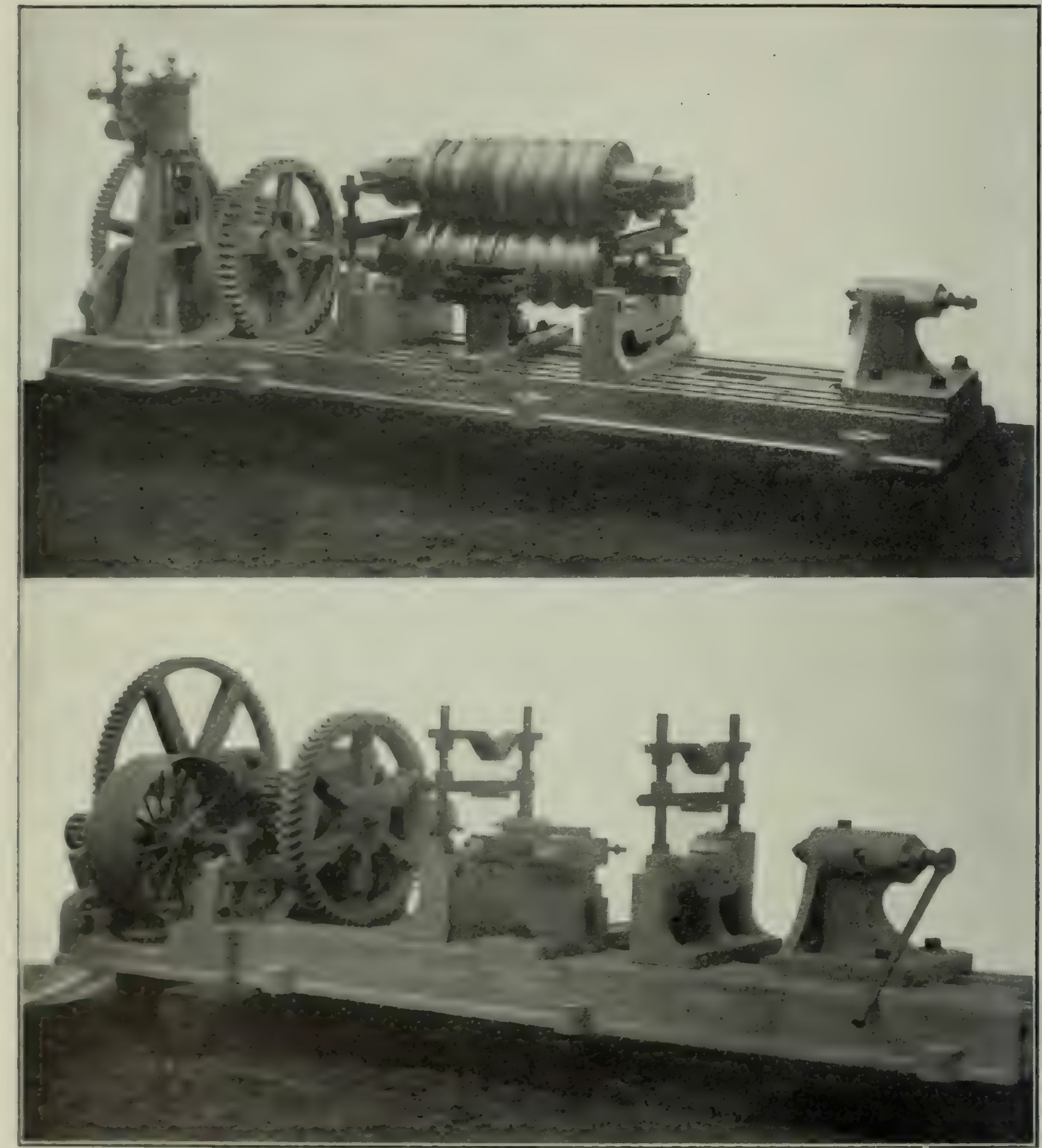
Roll foundries turn out rolls finished all ready to be put into the mill, as well as castings in the rough. They giving employment to quite a number of workmen. After the rolls have been a while in the mill, the grooves become rough and worn by the constant friction of the metal rolled, and need to be sent to the lathe to be put in shape. The roll turner takes off just enough metal to true them up, so that they will turn out smooth product again. This is called "dressing." The amount of cutting required varies greatly, depending chiefly on the kind of metal in the roll, length of time it has been in mill, and the character of the metal rolled.

By frequent dressing the rolls get smaller until they are too small for the mill; they then go to the scrap heap and are replaced by new ones. As a general rule they earn thousands of dollars for the company before being consigned to the scrap heap, although it does occasionally happen that a new roll breaks in two, or has a neck twisted off after a few hours of use. The rolls that are mostly in use by the mills are sand, chilled, semi-steel and steel rolls. Each of these kinds has its good qualities and its particular use for certain purposes. Sand rolls are made by pouring the metal into a mould made in sand, the best ones being made of gray mottled iron; this is a material that gives most excellent results when used for making bar-iron rolls, etc. Chilled iron rolls are made by casting in a metal mould; when the molten iron comes into contact with the sides, it cools quickly on the outside to a depth of 1½ to 4 inches and over. Chill depth depends upon the size of the rolls and the material they are to make, it being the usual practice of foundries to leave the center soft and tough, so as to prevent breakage, or twisting off of the necks. The characteristic of this class of rolls is their extreme hardness, a file making no impression on them. But the best ones are made just so hard that a first-class center punch will make a mark, and no more. This gives a degree of toughness to the dense, brittle material, and helps to some extent to prevent the rolls from breaking so readily. These



A LARGE ROLL LATHE, WEIGHING NEARLY 100 TONS, WITH VARIABLE SPEED DRIVE FOR VARIOUS KINDS OF ROLLS.

Bed plates [illegible] ft. long, [illegible] ft. wide, [illegible] in. deep; [illegible] centres; takes rolls up to 6 ft. in diameter, with necks from [illegible] to [illegible] inches diameter, and [illegible] tons in weight; cutting speeds from [illegible] to [illegible] inches a minute; each end driven independently by [illegible]-horse-power motor. [illegible] Ltd., [illegible].



EXAMPLE OF ENGINE AND BELT-DRIVEN ENGLISH ROLL LATHES.

The upper one has main bed 12 ft. long, 3 ft. wide and 9 in. deep, weighing about 2¾ tons; two change speeds; turns rolls up to 20-in. diameter collars. The lower is 14 by 4½ by 1 ft. bed, weighing 5¼ tons, capable of turning rolls up to 28-in. diameter of collars; driven by 6-in. belt on 3 ft. 3 in. pulleys at 152 revolutions; three change speeds. Both are by Thomas Perry & Son, Ltd., Bilston.

rolls are used to a great extent for finishing work, the grooves keeping their shape quite a while before requiring dressing. In using them care must be taken that no cold bars are run through, as pieces of the groove are liable to break out, thus ruining it for future use.

Steel rolls are used where great toughness with a moderate amount of hardness is needed; they are used for roughing, and also for shapes having delicate points, such as "finger bars," etc. They should be made of steel containing very small quantities of sulphur and phosphorus. The following is the analysis of a pair of open-hearth steel rolls that comes very near the ideal of what such rolls should be. In actual work they stood the battering acting of heavy manganese-steel ingots of all degrees of hardness for nearly sixteen months, and were then relegated to the scrap heap because they became too small for the mill.

Carbon combined	.49
Silicon	.211
Phosphorus	.041
Sulphur	.036
Manganese	.68

The mill should be so constructed and equipped with labor-saving machinery (and also with powerful engines) that there need be very little rehandling of coal, etc. Modern American mills are splendid examples of this, being operated with very few men and producing large tonnage at a minimum of expense. The up-to-date mill has a special shop for its roll turners, well lighted and so arranged that it can be warmed to a comfortable temperature in the winter.

Any one passing through a roll shop and observing a roll turner at work naturally concludes that he has a "snap"; nothing could be further from the truth, as he has a lot to contend with. Iron, steel, and copper work differently in various mills; this is due to the varying amounts of power provided to drive the train of rolls, and also to the way the material is heated for making finished stock.

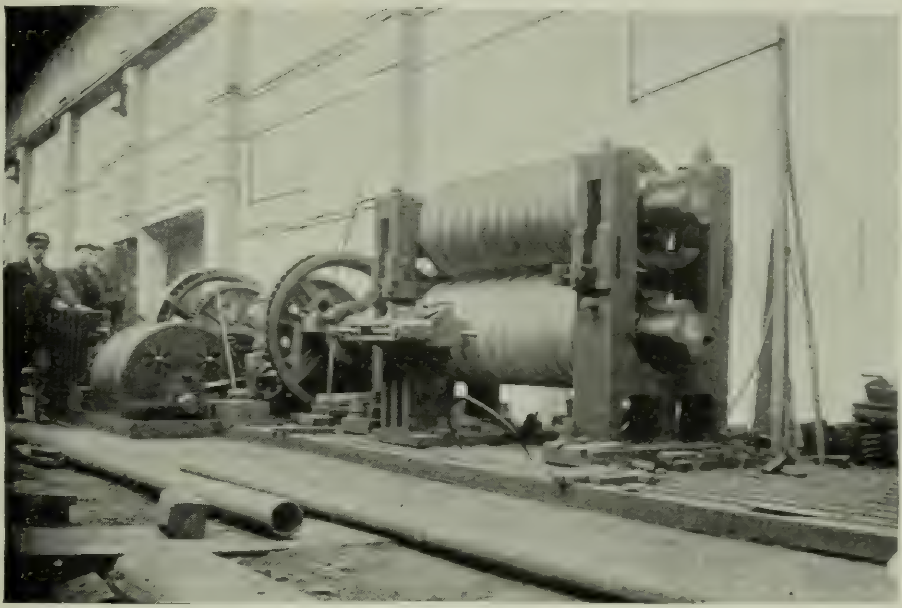
Rolls that work well in one mill will not work well in another, as some mills are very weak in engine power; therefore the drafts of the rolls have to be eased, etc. The roll turner has to be continually on his guard when he works in various places. However, the advantages that accrue from working in different mills are not to be gainsaid. As each one turns out a different line of product from the other, the roll turner who works in various mills gets skilled in every variety of work, and thus renders himself fit to take a "foreman" position, as the foreman must be a man skilled in designing and turning various kinds of rolls.

Many do not seem to recognize this fact, and stay at one situation all their lives, thus becoming specialists in their line of work, but rising to no higher position or wages than a journeyman gets. This accounts for the fact that some men are able to do only sheet work and others wire work, etc. Travel also broadens a man, as he is bound to come into contact with people of different dispositions, and overcome many difficulties in roll turning, thus learning self-control.

It is equally certain that he will get into some mills of an antediluvian pattern if he gets his situations by advertising. Considering the bad roll lathes and tools that some of these mills contain, it is surprising that the roll turner can turn out anything like decent work at all. Some lathes are so worn in gearing and bearings that they can be heard a square away. The housings are so broken and patched that they do not stay long in line with the bed, but twist and spring one way or the other, when a decent cut is being taken. Add to the above a roof that lets the water in onto the roll and lathe when it rains, and a condition is met with that taxes the patience and moral fibre of the roll turner. Some other firms put the lathes in the mill near the roughing rolls, the result being that the workmen stands a first-class chance of having an eye destroyed by flashes of hot metal from the rolls. Other parties have the "happy" (?) faculty of placing the roll lathe in the darkest part of the mill, and then generously allowing their roll turner to use a couple of small miners' lamps, each holding about two ounces of oil. These supply barely enough light in a dark mill to allow the workman to see where the point of the tool is going. In addition to all this, the journeyman generally freezes in the winter and roasts in summer.

In some of these old-fashioned mills, equally strange methods are used to put large rolls into the lathes, one of the most curious of these being the use of a large ship's capstan. This was situated about 50 feet away from the lathe. Above the latter, fastened to an I-bar, placed at a right angle to the lathe, and extending 6 feet in front of it, was a traveller, fitted with two ordinary ship's blocks. Located on the floor and secured firmly to a post was another block. A 2-inch rope extended from the capstan along the ground to the sheave of the block on the floor, and thence to the blocks fastened to the traveller over the lathe. The lower block on the traveller contained a large hook on the end. The method of procedure in putting in a roll was as follows:—the roll was placed by means of crowbars in front of the lathe; a chain with a ring in the middle and two hooks on the ends, was attached, the ends of the chain being placed around the wobblers, and the hooks run through the chain, thus holding the roll securely. The hook on the overhead block was run through the ring, the capstan bars manned by eight negroes, and the roll hoisted higher than needed. The traveller block holding the roll was pushed in until it was over the lathe, and the roll then lowered into place.

This method of doing business was exceedingly dangerous, as the rope was old and had many of its strands unravelled. Had that rope

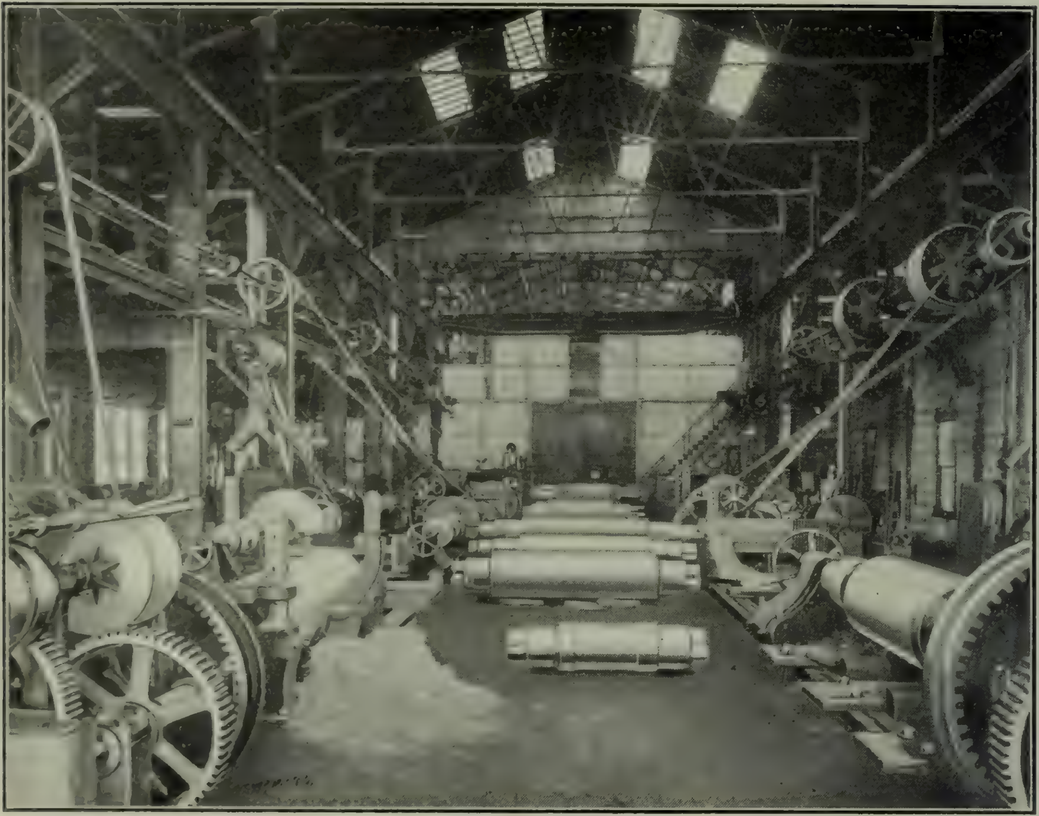


ELECTRICALLY DRIVEN COMBINED DOUBLE ROLL LATHE.

Each fitted on an independent bed plate, 19 ft. by 4 ft. 8 in. by 12 in.; headstocks 27-in. centers; both driven by one 20-h.p. motor; will turn anything from a guide mill roll to an 18-ton plate mill roll. R. B. Tennent, Ltd., Coatbridge.

broken it is most likely that some of the men working the capstan, and also those around the lathe, would have been killed or hurt. Another mill had its rolls put into the lathe by means of an inclined plane, they being rolled up it by workmen with crowbars; one man also kept placing wooden wedges to hold the roll, while the others secured another hold with the bars. When it arrived on the lathe rest it was rolled into position. One firm had a method of putting rolls into the lathe by means of jacks and a cribbage of railroad ties. This was accomplished by raising the roll by the jacks, then placing the ties under, letting the jacks down and taking a fresh hold and putting more ties under the roll. This performance was repeated until the roll was at the requisite height; it being then rolled into the lathe. It is most likely that such crude ways of doing business and wasting time will be done away with in the future, even in small mills.

A rolling mill should be erected where ample shipping facilities can be had, both by rail and water, it being of the utmost importance that the mill should have a free supply of water to cool the rolls and for condensing purposes. Some manufacturing plants are in such a location that they have to pay the water-works for all they use. This

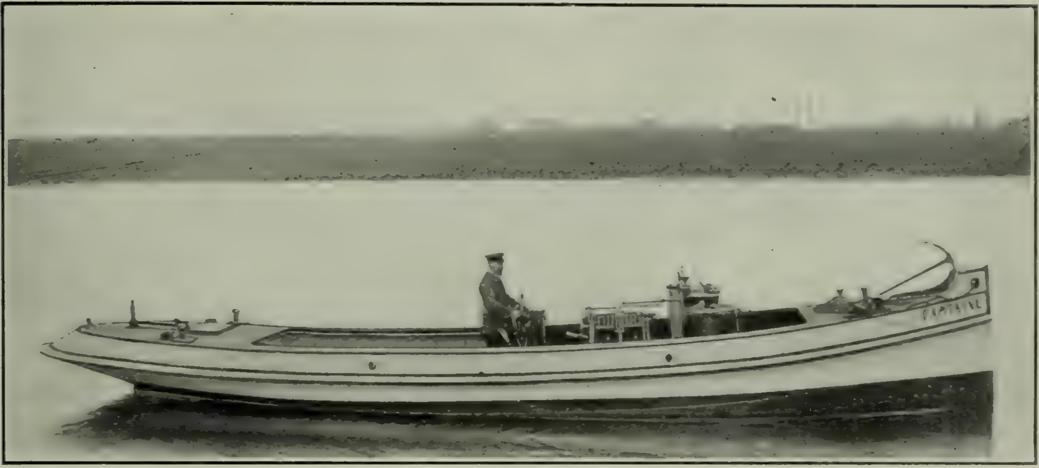


ROLL-TURNING SHOP OF THE LINCOLN FOUNDRY.
United Engineering & Foundry Co., Pittsburg.

adds considerably to the expenses of operating, and should be avoided. Another thing that ought not be overlooked is the fact that steel works, etc., should not be built in a town of less than 5,000 inhabitants, on account of the difficulty of keeping the skilled men, as the latter generally do not care to stay in small country towns where there are very few places of recreation. This is the reason why employers have such difficulty in getting skilled men to remain long in towns containing few inhabitants. Owners of mills prefer to have their plants in such localities on account of the taxes being low, but they do not take into consideration the above mentioned facts, finding them out later by experience.

The influence that new inventions and improvements exert upon the roll turning trade is most important, some of the shapes that the inventor creates calling for the utmost skill on the roll-turner's part in designing rolls, in order that the section may be rolled.

From the foregoing it may be readily seen that the roll turner holds a most important position in regard to helping to add to the comforts that the civilized nations enjoy, his being a trade that will probably last until the end of the world.



THE FIRST EXPERIMENTAL GAS-ENGINE-DRIVEN BOAT.

THE GAS ENGINE FOR MARINE MOTIVE POWER.

By Dr. Alfred Gradenwitz.

The rapid development of the gas engine, outstripping the highest estimates of its most enthusiastic advocates, naturally leads to the consideration of its applicability to marine propulsion. It is in that field that its possibilities of increased efficiency from equal fuel consumption attain their highest potential importance. Dr. Gradenwitz presents a comprehensive review of all that has been accomplished so far in this line of work, and of the mechanical principles involved.—The Editors.

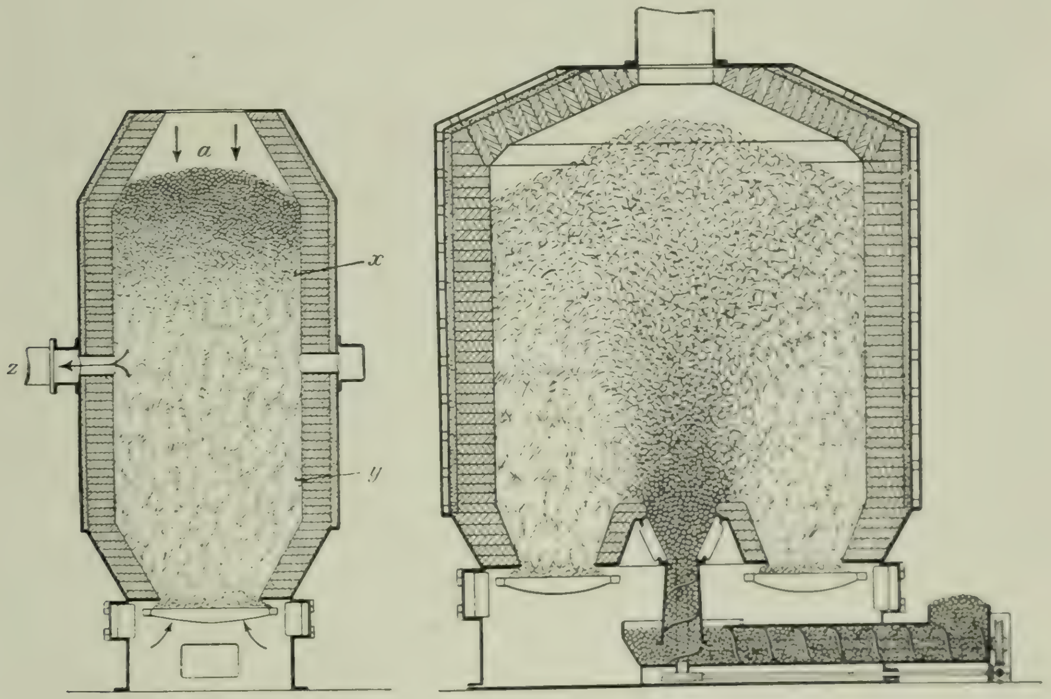
THE problem of constructing gas engines for the operation of ships is receiving much attention at the present moment, and pioneer work done in this line in Germany would seem to be especially noteworthy. It is a well-known fact that steam engines, in spite of the continual improvements in their construction, effect but a rather imperfect utilisation of fuel; nor does it seem likely that an efficiency much higher than 16 per cent. should ever be obtained by marine steam engines, either reciprocating or turbines. On the other hand, it is obvious that a utilisation as perfect as possible of the fuel is of special importance on board ships, where the amount of coal carried constitutes a heavy charge and calls for an increase in the dimensions of the vessel, involving in turn the necessity of a higher power and great coal store, and so on. This point assumes especial importance in connection with warships, where the

TOWING BARGE DRIVEN BY GAS ENGINES.

radius of action necessarily depends on the amount of coal carried. It may safely be stated that an engine requiring only half the amount of coal necessitated by present-day steam engines would enable the radius of action of these ships to be raised to about twice its value.

The increasing installation of gas motors in connection with stationary operation necessarily suggested the idea referred to above, of using the same type of prime mover also for the propulsion of ships. Internal-combustion motors, mostly operated by liquid fuel, have, it is true, long been used with small sized boats, and even as auxiliary engines in large river barges and sea-going ships. But any gas engines which so far have been used for this purpose were merely heavy units, identical with those constructed for stationary operation, no endeavors being made to adapt them for their special use.

In the stationary gas producer, the production of tar in connection with the gas is a matter of minor importance, since there is no difficulty in employing condensers to separate and remove the tar before the gas is delivered to the engine. On shipboard the addition of a condenser adds materially to the weight and bulk of the apparatus, and yet it is important that no tar should be allowed to reach the engine, because of its injurious effect on the working parts. In the marine gas producer, therefore, it is necessary to regulate the production in such a manner as to convert the tar entirely into noncondensible gas. This is effected by the arrangement shown in Figure 1, in which the fuel is so disposed as to form two gasefication layers, one above the other, the gas being taken off at the middle. The coal is charged at *a*, and the separation of the tar takes place in the upper layer, the separated tar passing down through the lower stratum of incandescent coke, where it is dissociated by the heat and fixed as permanent gas. Air and steam being delivered into the ash-pit below the grate, there is generated in the lower part of the producer a semi-water-gas, consisting of carbon monoxide, hydrogen from the dissociated steam, and inert nitrogen, this mingling with the gas formed from the tar, and passing out at *Z*.



FIGS. 1 AND 2. TYPES OF MARINE GAS PRODUCERS.

As, however, the use of the two superposed layers increases the height of the producer, this construction has been modified by Capitaine as shown in Figure 2, where the tar likewise traverses an incandescent layer, but of smaller height. The coal is fed mechanically into the producer pit from below and raised to incandescence under a supply of air, while the separated tar is made to traverse the superposed high layers of incandescent coal. The fresh coal being thrown upwards violently, its mechanical crushing is readily effected, the incandescent coal preventing by its motion the formation of solid slag.

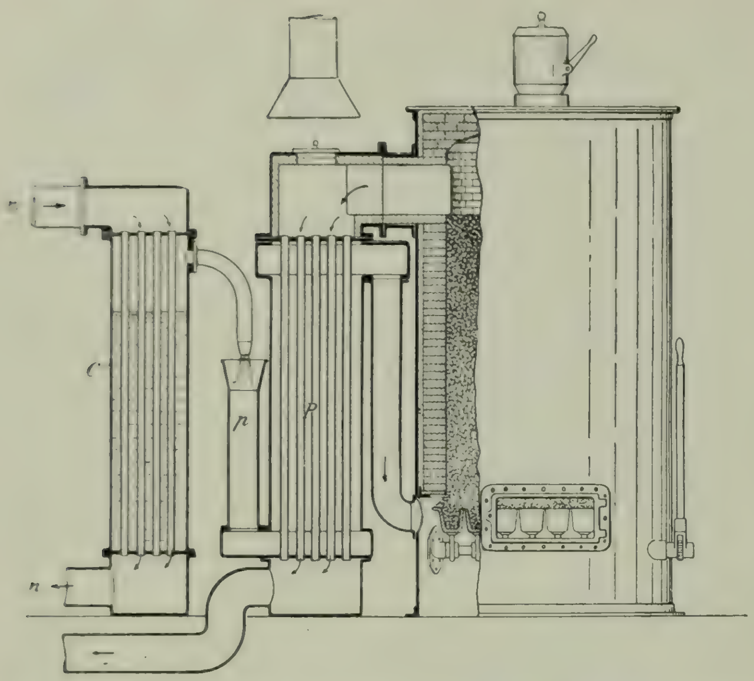


FIG. 3. GAS PRODUCER UTILISING THE HEAT OF THE ENGINE EXHAUST IN THE VAPORISER.

As a further step toward increasing the efficiency of the producer, the heat of the exhaust gases from the gas motor has been utilised to advantage for raising the steam necessary to the producer. In Figure 3, B is the steam producer, into which the hot exhaust gases coming from the gas engine are introduced at *m*, giving off their heat to the heating tubes and escaping into the open through the tube *n* which is at a low temperature. The steam evolved, being mixed with air, flows through the pipe *p* into the heater P, where the heat from the hot gases arriving from the generator is transmitted to the steam-and-air mixture, so that the latter reaches the incandescent coal of the producer in a highly pre-heated condition. If the two heat-exchanging devices C and P are well designed, the efficiency of the producer may be so augmented that from 90 to 95 per cent. of the heat contained in the coal is recovered, in the state of chemical energy in the gas produced.

The amounts of water required for the steam to be decomposed in the producer are as a minimum .20 kilograms in large plants for each effective horse power hour, assuming the coal consumption per horse power hour to be .36 kilograms, while in more advantageous cases they exceed the weight of the coal used. As there is no possibility in gas engines of recovering water by condensation, these amounts of steam must be generated directly from the water of the river.

In the case of sea water, an ordinary vaporiser such as represented in Figure 3 cannot be used, the residual salt giving rise to rapid incrustation. In order to avoid this, a special vaporiser has been constructed (Figure 4) in which the concentration of the sea water can never exceed a given degree. This is effected by a continuous passage of water through the steam generator, the fresh water entering at *a*, flowing upwards through the coiled pipe *t*, whence it enters the steam generator, where the concentration of the water is increased up to 3 to 4 per cent. by vaporisation. A continuous discharge of saturated hot water in the compartments then ensues, its heat being given off to the coil and heating the fresh water. If the heating surface of the coiled tube be adequate, the loss of heat due to the continual passage of water is extremely low. The working of such sea-water vaporisers is continuous, no cleaning being required, except at very great intervals.

One of the greatest difficulties experienced in the use of gas producers for the operation of ships is the fact that the temperature in the producer decreases in the case of a temporary stoppage, or if the engine works at half its output, so as not to allow of its resuming full duty immediately afterwards. The greater the dimensions of the producer, the longer will the proper temperature be maintained in the interior even in the cases just referred to, while in the smaller types of producers (up to 150 horse power) the fall of temperature is relatively rapid.

This problem has been solved in a double way by Mr. Capitaine. In the case of reduced gas consumption, the coal is gasefied only in such layers as have an outside transmission of heat, while on the other hand the producer is heated by its own gas as long as it is not warmed sufficiently by a normal gas consumption.

As regards the type of motor developed by Mr. Capitaine, the four-cycle type with two or four cylinders has been adopted, while the use of quick-running engines has been avoided, the principal

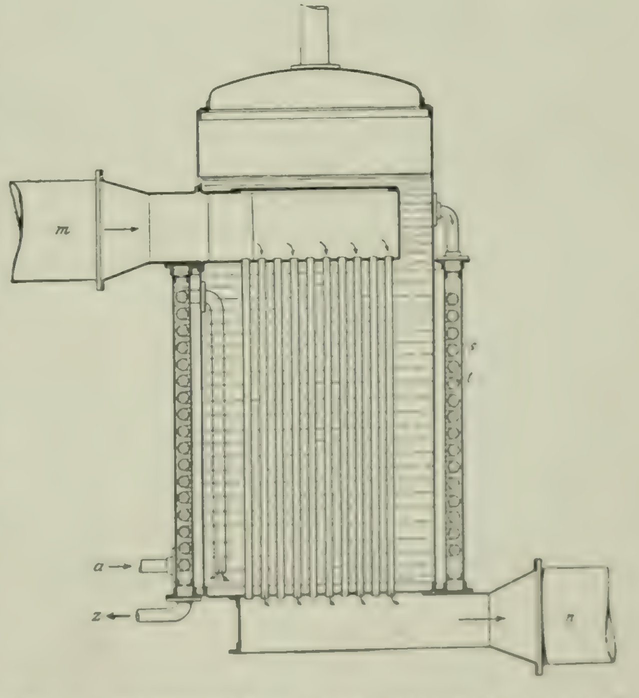
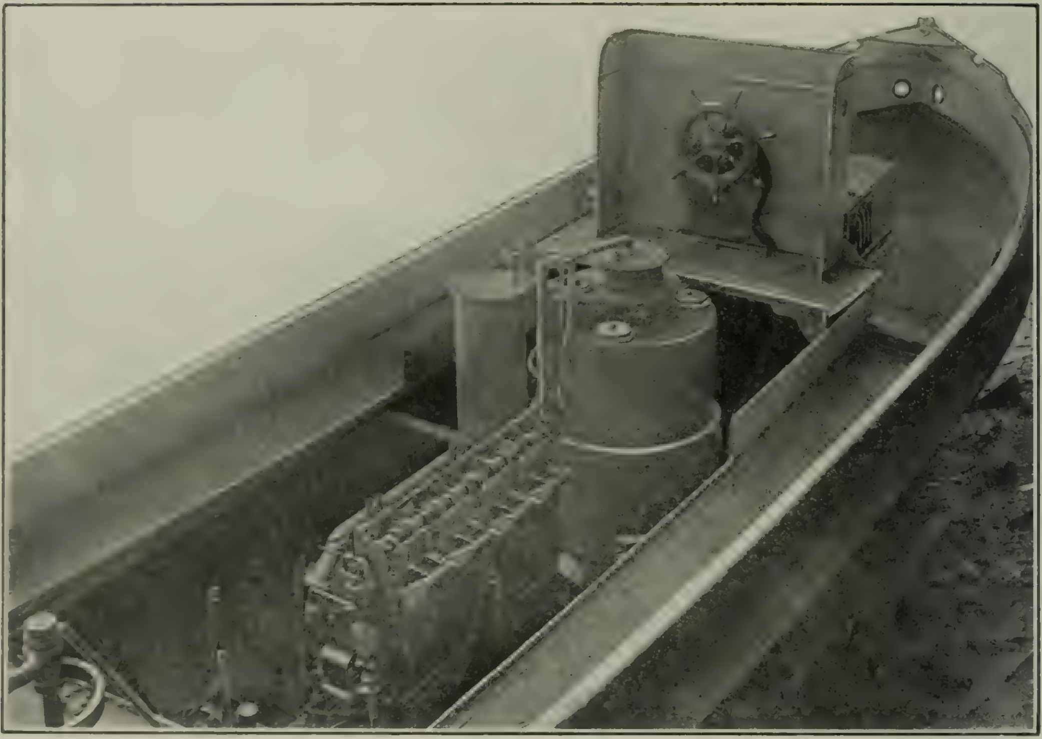


FIG. 4. VAPORISER FOR USE WITH SEA WATER.



SHOWING THE SPACE OCCUPIED BY AN 80-HORSE-POWER MARINE GAS ENGINE WITH ITS PRODUCER.

point sought being solidity in design. In the smallest type of marine gas engine (20 brake-horse-power) the number of revolutions is only 380 per minute as a maximum, being 320 with 40 to 80 brake horse power, 220 with 150 brake horse power, 180 with 300 brake horse power, and finally only 120 revolutions for the larger outputs (500 to 1,000 brake horse power). Figures 5 a, b, c, d, show a four-cylinder engine of 80 brake-horse-power maximum output, while pages 348 and 352 show a hauling barge fitted with this engine, and page 347 represents the first experimental gas boat (of 25 brake-horse-power output) that has been operated by marine gas engines proper.

Single-action cylinders have been chosen on account of the higher safety in working warranted by such engines, all the working parts being more easily accessible, the engine being lower and the reciprocating masses smaller. By using four cylinders, as indispensable for a uniform running in connection with a small flywheel, the dimensions of the motor housing are relatively great. Instead of screwing the cylinder gland to the cylinder, as is ordinarily done, the cylinder A (see Figure 5) is fixed to the cylinder gland—i. e., the combustion chamber F. In order to disconnect simultaneously the cylinder with the piston valve from the interior of the combustion

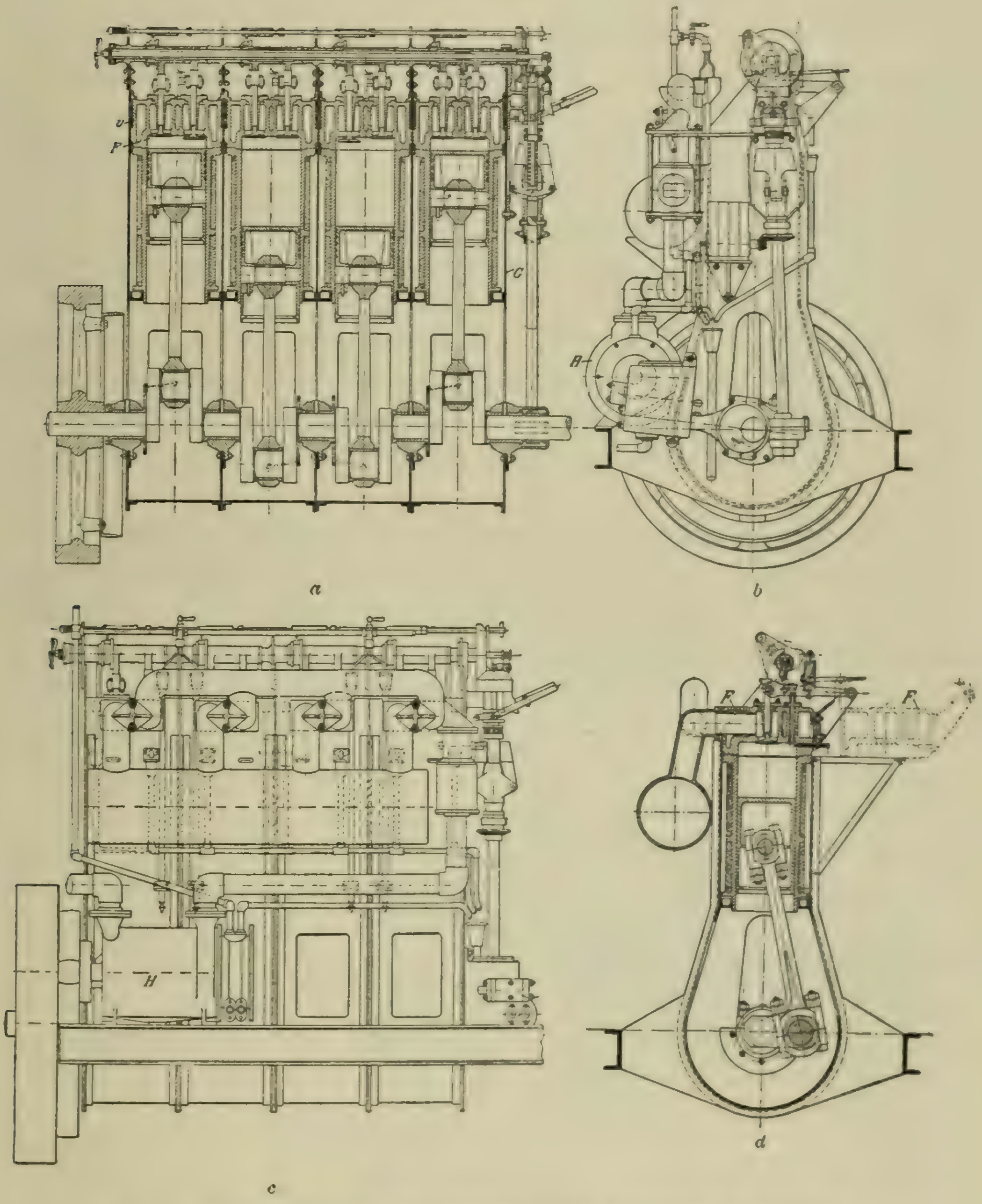


FIG. 5. FOUR-CYLINDER 80-HORSE-POWER MARINE GAS ENGINE.

chamber, there are only four comparatively small bolts to be loosened.

The body of the motor is made of sheet iron, giving a minimum weight with maximum strength. In order to clean or to overhaul the cylinders, pistons, and working parts, there are no other parts to be removed.

The timing of the ignition should be altered according to the varying numbers of revolutions, in the case of slow-burning producer gas; this is effected by the regulator, shifting automatically the time of ignition, so as to have this always occur at the most favourable moment. The regulator being adjusted by hand in course of operation, the engine is adjustable to any number of turns, and is regulated economically.

The consumption of coal per hour and per brake horse power in the case of a 10-horse-power motor is 0.5 kilograms, with a 30-horse-power motor, 0.40 kilograms, and with a 100-horse-power motor, only 0.36 kilograms. Calculating the price of the coal used at 50 cents per 100 kilograms, the brake horse power in a 30-horse-power plant will work out at about 0.2 cents per hour. There is obviously only a comparatively very small supply of coal required as compared with steam engines, the latter consuming generally 1½ to 2½ kilograms per hour and brake horse power with 10 to 20-horse-power engines.

A marine gas engine of 25 horse power requires a floor surface of 800 by 1,900 millimetres and a height of 1,300 millimetres above the floor. In the case of a 50-horse-power engine, the vertical and lateral dimensions are exactly the same as in a 25-horse-power motor, while the length is augmented by about 700 millimetres; the weight

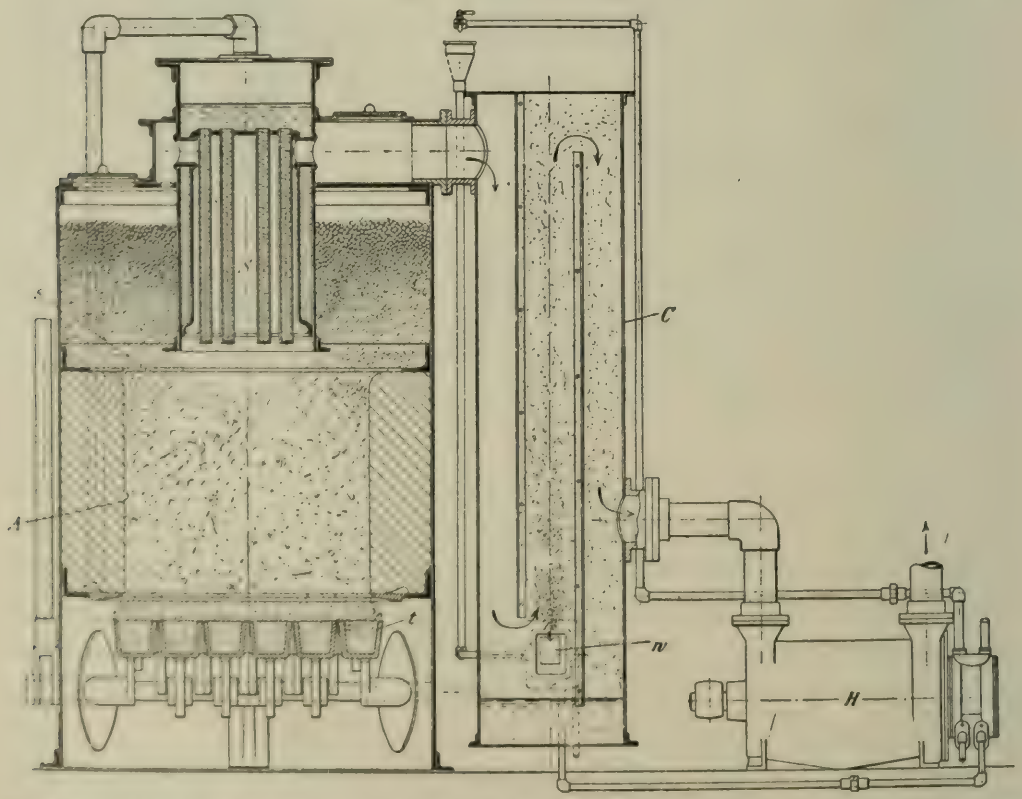


FIG. 6. PRODUCER PROPORTIONED TO THE 80-HORSE-POWER ENGINE SHOWN ON THE PRECEDING PAGE.

is only about 25 per cent. greater than that of the 25-horse-power motor.

The motors are started by compressed air in the well-known way, for which purpose a small compressed-air tank is fitted below the floor. The 25-horse-power motors have two cylinders, while those of from 50 to 400 horse power are fitted with four cylinders. In the case of twin-screw boats, using two 400-horse-power engines, a maximum output of about 800 horse power is secured by the new motor. For starting the motor and blowing in the producer a small auxiliary engine is provided, operated by benzine or petroleum; this seldom works for more than a few minutes per day.

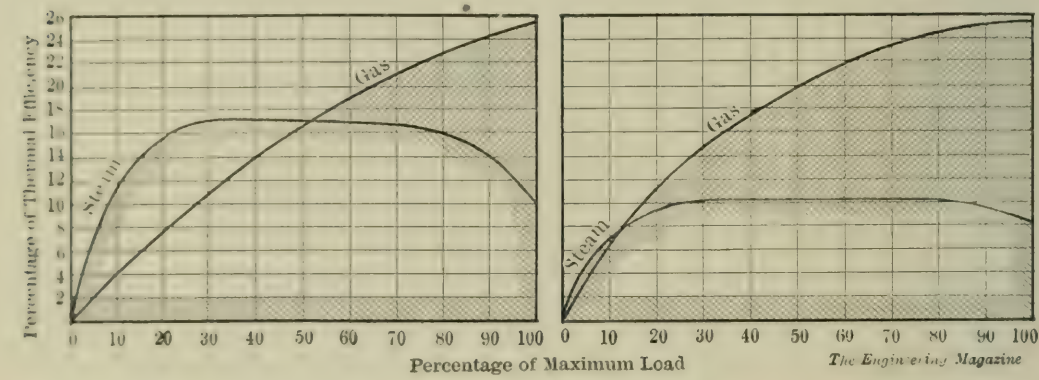
An 80-horse-power producer corresponding to the engine shown in Figure 5 is represented in Figure 6.

It has so far been impossible, in small-sized producers (of less than 300 brake horse power), to use ordinary bituminous coal without inconvenience, so that anthracite and coke have still to be used. The producer represented in Figure 6 is designed for anthracite operation, the steam generator S lying immediately above the incandescent layer and being surrounded by the coal, which constitutes a rather perfect heat protector; this coal falls through the annular slot *s* into the gasefication pit A. The grate consists of trough-shaped bars t, which, being filled with ashes, offer only a very small contact surface with the incandescent coal but a very large radiation surface downwards. Experience has shown this grate not to be affected by superheat even when highly pre-heated air is used.

The produced gas, passing through the vaporiser S, enters the cooling and cleaning vessel C, where water is divided as finely as possible by air and a vaporiser *n*, and so to say, transformed into a cloud. The surface offered by the water to the gas is thus greater and the contact of the water and gas more intimate than has heretofore been effected in so small a space.

The cloud formed in the gas by the novel vaporisor *n*— i. e., the intimate mixture of water and gas—is led into a specially constructed centrifugal device, H (see Figures 5a, and 5c) driven by the engine, where it is submitted to an extremely energetic centrifugal effect with about 100-metres peripheral speed per second, when the water particles are separated perfectly from the gas, together with any tar and ash particles suspended in the gas. Some amounts of solid sulphur are likewise separated in the centrifugal outfit, so that the gas is brought to a state of purity quite sufficient to warrant safety in operation.

In a lecture recently delivered before the German Society of Naval Engineers (*Schiffbautechnische Gesellschaft*), Mr. Capitaine offers the following suggestions on the economic side of the operation of marine gas engines:—The undoubted superiority of gas engines over steam engines in regard to thermal efficiency, holds true only as long as the load approaches the full figures, while in the case of reduced performance, the thermal efficiency is found rapidly to decrease, becoming about identical with that of a stationary steam engine with 50 per cent. load.



FIGS. 7 AND 8. DIAGRAMS OF THERMAL EFFICIENCIES OF STEAM AND GAS ENGINES.

In Figure 7 the diagrams of thermal efficiencies have been drawn both for a gas engine and a highly perfected stationary steam engine, supposing the angular speed to be constant. In the operation of ships, the gas-engine curve will, it is true, prove somewhat more advantageous, the reduced output involving a decrease in the number of revolutions—that is to say, a diminution of the frictional work—so that the curve, as shown in Figure 8, becomes steeper. On the other hand, the curve of steam engines fails to attain the height represented in Figure 7 for the case of stationary engines. While a thermal efficiency of 17 per cent. seems hardly ever to have been secured in connection with marine steam engines of the greatest outputs, smaller types of about 100 horse power are known to use about 1 to 1.2 kilograms coal of 7,000 degrees C for each brake-horse-power hour, giving a thermal efficiency of less than 10 per cent. A characteristic feature of steam engines is the fact that their thermal efficiency becomes lower as their output is smaller, while present-day gas engines show practically an opposite behaviour.

From the above, the great superiority from a thermic point of view of marine gas engines with smaller outputs will be evident; and though the price of anthracite and coke be about 50 per cent. higher than that of the coal used for the operation of steam engines, the economical advantage will still be quite material, the cost of fuel in a gas engine of 100 brake horse power, for instance, being less than half that of an equivalent steam-engine. As the output increases, the economical superiority of gas engines as compared with steam engines is found to increase as far as the limit where anthracite and coke can be replaced by cheap coal, when the profit at first increases again, to become problematic with about 1,000 brake horse power, owing to the difficulties inherent in ship operation. At all events, the saving in weight and in space as compared with rationally working steam-engines remains considerable up to 1,000 horse power.

As regards the steering of marine gas engines, which is one of their weak points, Mr. Capitaine uses either an adjustable screw of the Meissner type or an inverting gearing, while for outputs of more than 200 horse power neither of these devices proves satisfactory, and steering by compressed air, inverting the sense of rotation of the engine-shaft, is being resorted to.

As the power of the engine increases, the mass of the flywheels required will augment to an extraordinary degree. In fact, the higher the output of the motor the greater will be the stroke and the larger the reciprocating masses, such as the piston and connecting rods. As in the operation of ships the use of heavy foundations, as usual in stationary operation, is quite out of the question, while oscillations should be strictly avoided, a speed of the piston of upwards of 4 metres would seem to be quite impracticable; this would involve a low angular speed in connection with relatively small cylinder bores and long piston strokes. If the number of revolutions be diminished still further, as would be the case with slackened speed, present-day gas engines would prove extremely unsatisfactory in working, the extremely hot gases being allowed to pass on to the cooled walls, i. e., to cool down.

In Figure 9 are shown the diagrams of the high-pressure cylinder of a triple-cylinder expansion steam engine and of a gas engine, while Figure 10 shows the dimensions of the

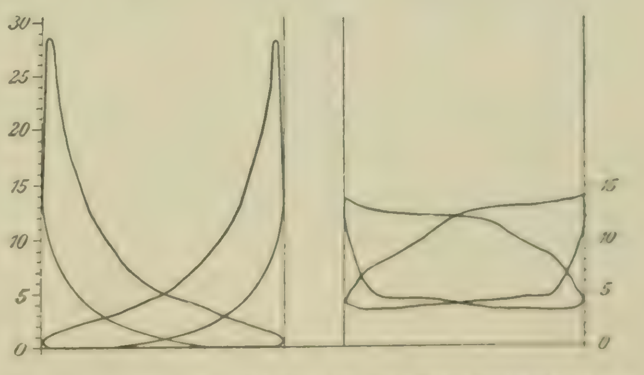


FIG. 9. INDICATOR DIAGRAMS OF TRIPLE EXPANSION STEAM ENGINE, (HIGH-PRESSURE CYLINDER) AND OF GAS ENGINE.

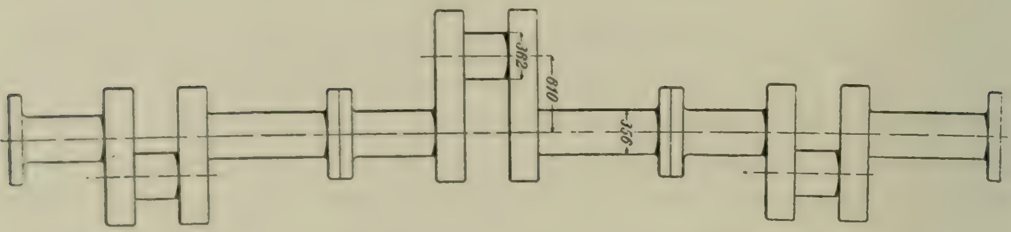


FIG. 10. CRANK SHAFT OF MARINE ENGINE OF 2,000 HORSE POWER.

crank-shaft of a marine steam-engine of 2,000 indicated horse power with 75 revolutions. It will be seen that the maximum pressure of the steam engine is about 15 atmospheres, with a useful average pressure of 6.8 atmospheres, while the maximum pressure of the gas engine should be taken at 30 atmospheres, the useful average pressure being, however, no greater than that of the steam engine. This shaft, which has been calculated for a 2,000 indicated-horse-power steam engine, would, for the same number of revolutions, be suitable only for a gas engine of little more than 1,000 horse power, even in case six cylinders are arranged in pairs.

Present-day gas engines are, according to the above, in a position to compete with steam engines in the operation of ships only as far as concerns outputs of less than 1,000 brake horse power (or 2,000 electrical horse power in the case of twin-screw).

The suitability of the Capitaine gas engines has been borne out already by trials of small-sized boats, while Messrs. William Beardmore & Co., Ltd., of Glasgow, and John I. Thornycroft & Co., Ltd., London, have undertaken the construction of a four-cylinder marine gas engine of 600 brake-horse-power output (to be possibly increased up to 900 electrical horse power, corresponding with a steam engine of 1,000 indicated horse power), so that a definite demonstration of the practicability of gas ships can be anticipated for the course of this year.

The economical bearing of a possible introduction of gas ships can hardly be underrated, allowing as it would of many millions being saved in coal, so that the waterways, owing to the cheaper gas operation, might become much more powerful competitors to railways than heretofore.

THE GENERAL STORES-KEEPING DEPARTMENT OF THE BROWNING ENGINEERING CO.

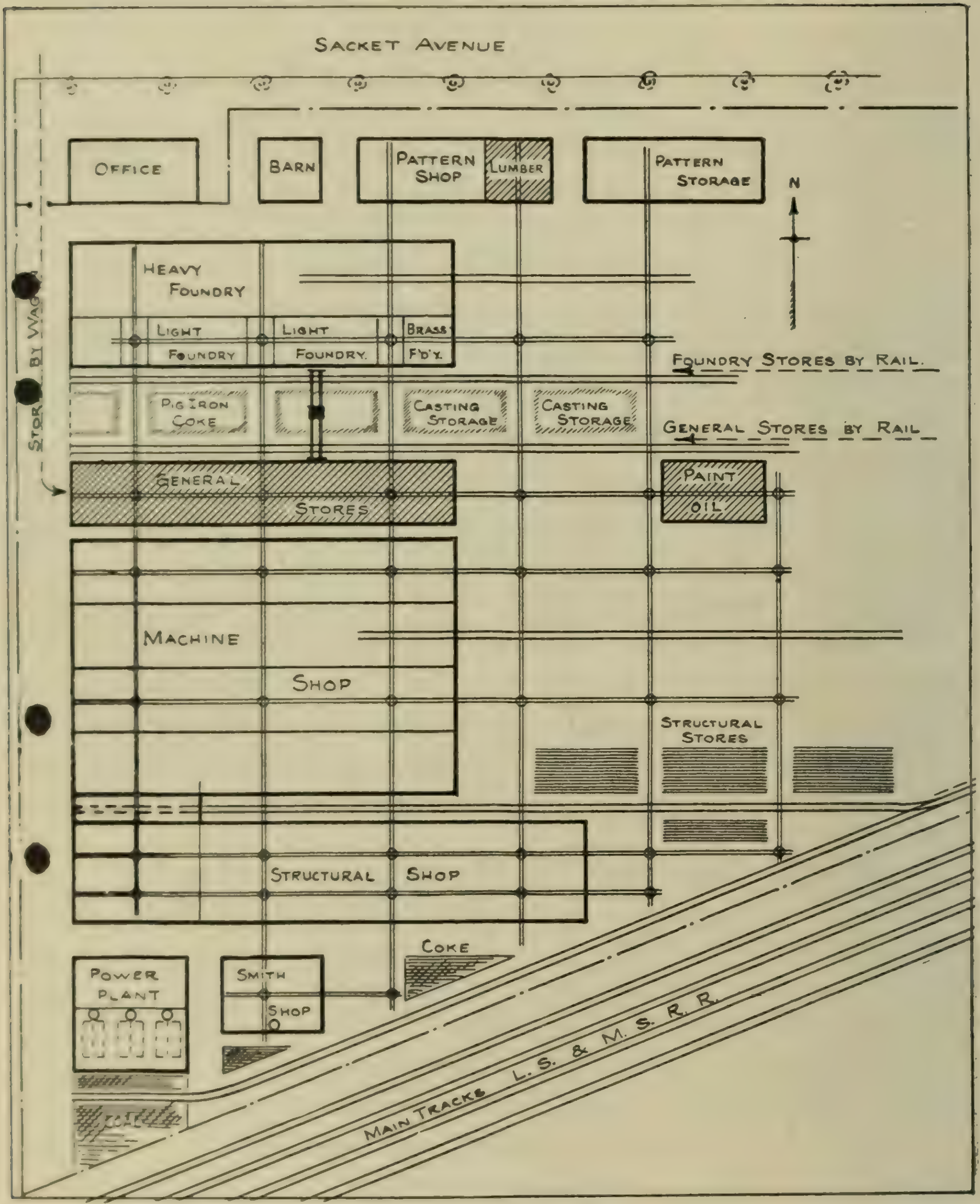
By Earl Harrison Browning.

Mr. Browning's article is the third in the series descriptive of stores-room systems in actual use, the purpose in each case being to have the account given by an administrative officer directly in contact with the working of the shops. Mr. Browning is the works manager of his company, which manufactures traveling and locomotive cranes and hoisting machinery. Preceding articles in the series have described the methods of the Pond Machine Tool Works and the National-Acme Manufacturing Co.—THE EDITORS.

IN the modern plant of today for the manufacturing of machinery, the responsibility of the business is generally distributed among the managers of the administrative, financial, sales, and manufacturing departments. The work of the manufacturing department may be again divided and assigned to as many sub-departments as may be found necessary for the rapid and economic production, and it is now generally conceded by the modern works manager that one of the most important of these sub-departments is the one which collects the material necessary for the operation of the plant, or "The General Stores-keeping Department."

It was early demonstrated to The Browning Engineering Company that the only possible way to prevent constant shortage, to reduce the stock to a minimum, to keep a perpetual inventory of all material on hand, to insure its being charged to the right account when delivered, and—most important of all—to prevent delays in the manufacturing departments by having ready to deliver the proper material when required, was to create a general stores-keeping department for both finished and unfinished material used by the entire plant, and (in order to locate the responsibility) to place this entire department in charge of a general stores keeper, and give him a sufficient number of clerks and laborers to keep the records and handle the material, and relieve, absolutely, all other employees.

The large variety of materials to be handled made it impossible to adopt any one method of storing them which would meet all conditions satisfactorily. While some were not materially damaged by a short exposure to the weather, others would be ruined by the least moisture. There were light and heavy, long and short, wide and narrow pieces; some were regular and piled up nicely, and some



A GENERAL PLAN OF THE WORKS.

Showing central location of General Stores. Paint and oil are stored separately, to reduce fire hazard, lumber and structural stock, and coal and coke being stored where used, to reduce cost of handling.

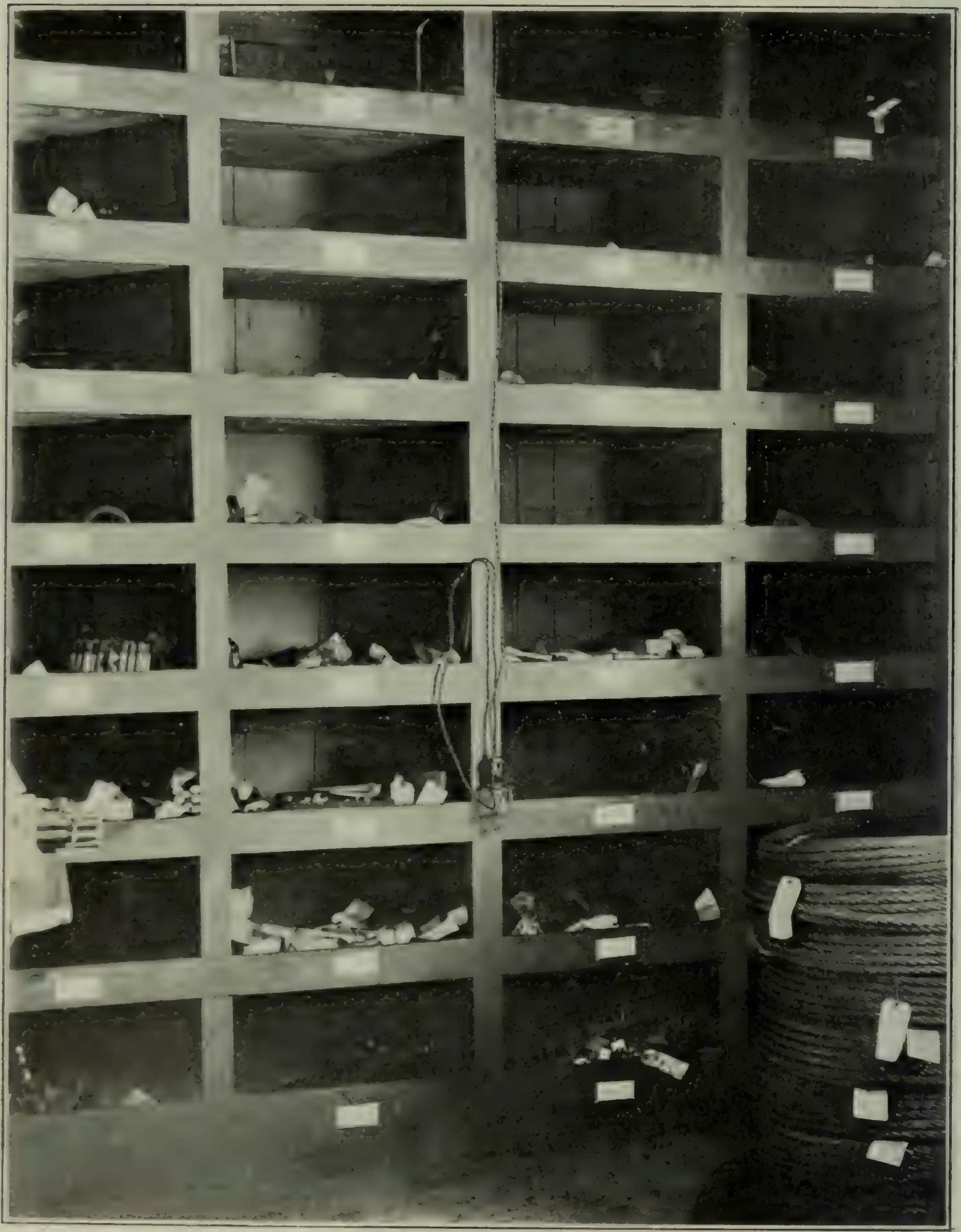
were frightfully distorted and refused to be arranged with the least semblance of order. There were solids and liquids, some used by only one department and some by all. To meet these varied conditions best, the company decided to erect a building for all the perishable stores that were not especially inflammable; to build a second building for the paints, oils, and combustibles; to inclose a yard, by means of a high fence, for the storage of small castings and small articles not affected by the weather; and to adopt a system, as here explained in detail, for the receiving, storing, and delivering of the materials.

This system is not intended to be an ideal one to meet the conditions in all manufacturing concerns, but simply the present form of one which best suits the peculiar and particular business of this company.

To distribute the material from this central storage, a system of narrow-gauge tracks is used, by means of which, with turntables and small cars, any department can be reached.

THE GENERAL STORES KEEPER'S OFFICE, DESK, AND RECORD FILES.
The cases are sectional, made of hard wood and of the same dimensions as the stock-room cases. The drawer sections contain the stock records, on cards.

The main stores building is divided into two parts by the office and reserve store room, which are located near the center. In the office all the records are kept in writing and as nearly up to date as possible, neither memory nor individuality being depended upon. The forms upon which the records are kept in all the departments throughout the office and works are of the same dimensions and filed in the same manner. The full-size record sheets are $8\frac{1}{2}$ inches by

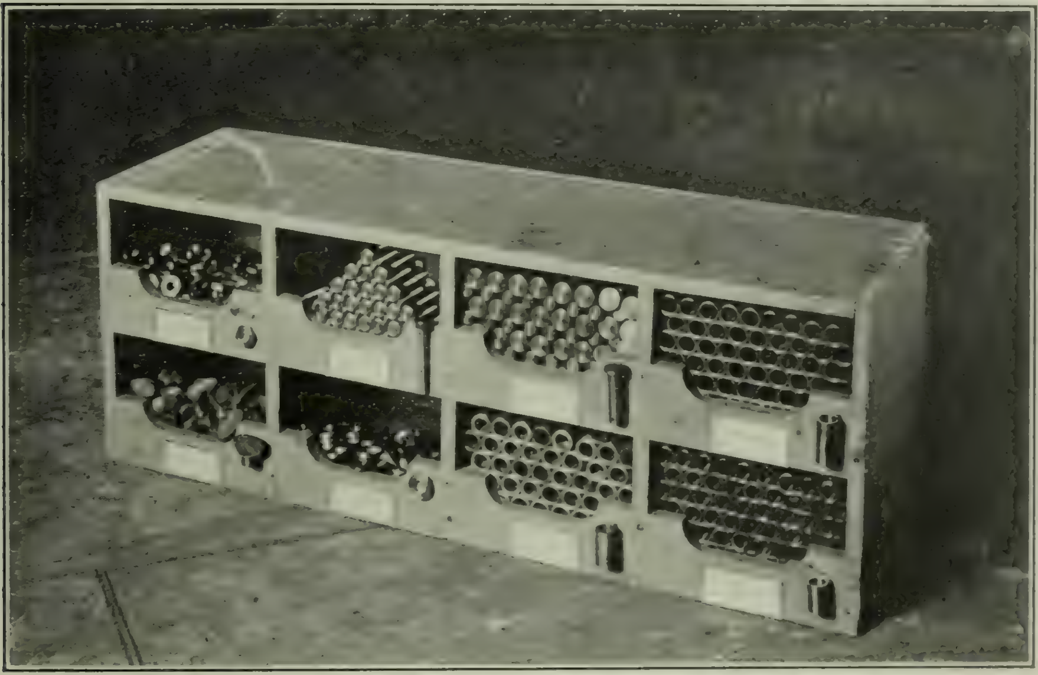


A PART OF THE ROOM FOR MATERIAL RESERVED FOR THE FITTING DEPARTMENT. Each of the reserve stock bins represents an order, and all material therein is tagged and completed ready to assemble.

11 inches, with 1 inch margin on the left-hand side, and are perforated to suit the loose-leaf files. The files in daily use are bound in leather and may be quickly opened at any place to remove or insert a page. The files to which this matter is later transferred are plain canvas backs, and are kept in sectional cases as shown in the view of the general stores-keeper's office. The half-size records are

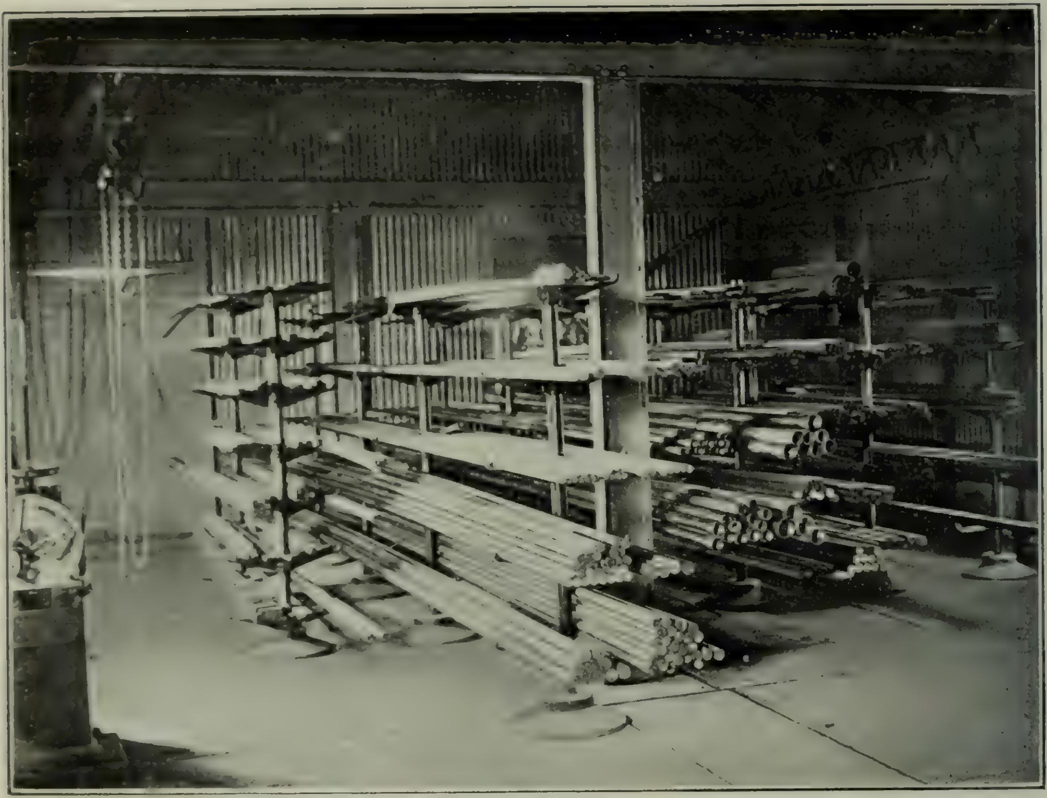
5½ inches by 8½ inches, and are filed in sectional cases of drawers as shown. The ordinary index cards used in the cost and time-keeping departments are filed in drawers in the same manner.

The reserve stock room, from which all material is delivered, is filled with bins for the small material reserved for all the various shop orders until the shop is ready to receive it. Each bin represents the material on one order as described by the card in the pocket. This room is provided with several delivery windows, each one having a call bell to attract the attention of the delivery clerk.



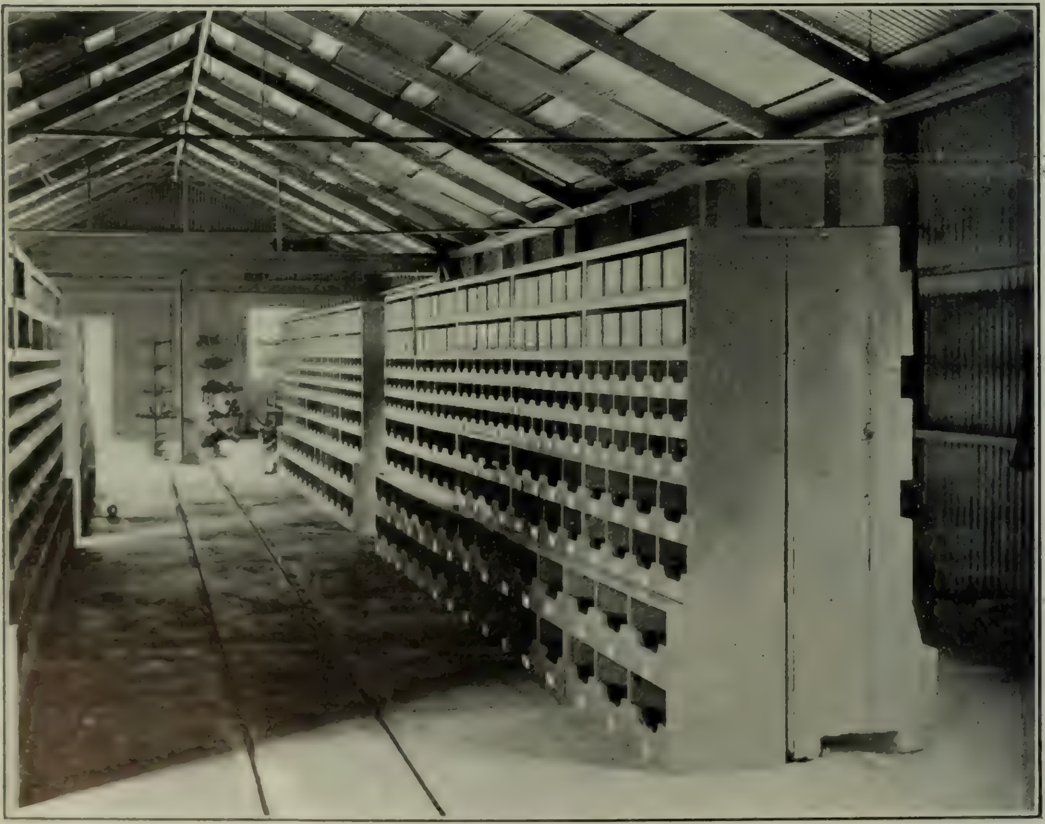
ONE UNIT OF THE SECTIONAL CASE FOR SMALL PARTS.
The card in the slide gives the full history of the piece contained in the bin. These particular parts are engine details.

The larger part of the main building, in which is stored all the crude stock as well as all unassembled finished parts, is equipped throughout with sectional cases, with units 18 inches high by 15 inches deep and 4 feet long, made of wood and having any number of compartments from four to eighteen to a unit. These can be moved, piled, and arranged to suit conditions, and in them are stored all material such as nuts, bolts, screws, cotters, washers, rivets, pipe fittings, springs, and very small castings, as designated by the card in the holder fastened to the front of each compartment. For a few articles there are shelf and drawer units of the same dimensions as the compartment sections. These, with the compartment cases, accommodate almost everything in the main building except the bar material and some miscellaneous supplies.



RACKS FOR STORING BAR MATERIAL.

Tool steel, drawn steel, soft steel, brass rod, etc.; the separate racks are single, on stands, and as many may be used as the length and weight of the stock require.



STOCK BINS, BUILT UP OF SECTIONAL COMPARTMENT CASES.

For small hardware, etc.; each section being a unit, they may be assembled in any convenient form.

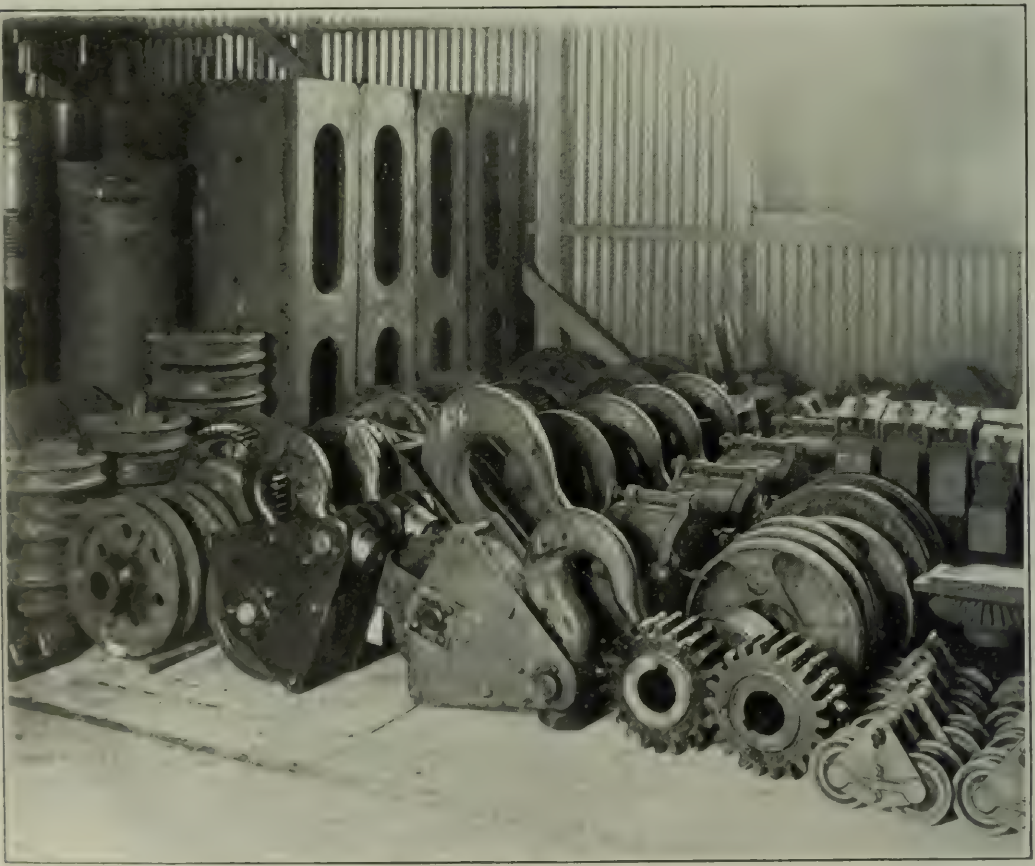
For bar stock, pipe, draw steel, tool steel, brass tube, and rods, etc., special individual racks with heavy cast bases, pipe uprights, and cast arms are used. These are portable and can be placed in any manner desired to suit the stock, and the material can be kept cleaner, more accessible, and in better light. The heavier bars are placed on the lower arms, the lighter above. A small hand-power crane runs over all of these, as well as over the cutting-off machines, saws, and pipe cutters, which are located near the racks and are in charge of the general stores keeper. For a few miscellaneous supplies special provision is made; for the fire-clay, cement, asbestos, salt, boiler compound, etc., ordinary oil barrels well cleaned, painted, and labeled, with loose covers, are used. For the iron, steel, and brass wire a rack of reels. For the wire rope, block asbestos, chain etc., nothing better has been devised than to pile them up on the floor as neatly as possible.

SHELF RACKS FOR STORING MEDIUM-SIZED FINISHED PARTS.

The division pieces on the shelves may be arranged to suit various requirements.

The unassembled finished parts, such as bushings, special pins, bolts, nuts, small forgings, and castings, are stored in the same sectional cases and are treated the same as the purchased stores, the card in the pocket giving all the information possible to identify it, such as piece number, drawing number, shop-order number, description, location on machine, and size of machine. To assist further, a sample piece is fastened on the front as shown on page 363.

The remainder of the main building on the other side of the office and reserve stock room is reserved for the finished parts which require no further assembling until the final shipment. These are the most difficult of all for which to provide an adequate and convenient method of storing. The lighter and smaller parts are stored on portable shelves made of the same heavy bases, pipes, and cast arms as used for the bar material. The larger and heavier parts are piled on the floor. These parts are handled in a manner similar to the other stock and are delivered to the assembling floor when orders for shipment are received.



STORAGE FOR LARGE FINISHED PARTS.

Showing the method of piling pieces which are too large to be stored on racks.

The separate building for the inflammable materials, which is some distance from any of the other buildings, is made of corrugated iron laid on an angle frame and provided with a cement floor. For the kerosene, gasoline, and machine oils larger tanks with pumps attached are used to reduce the waste from filling cans.

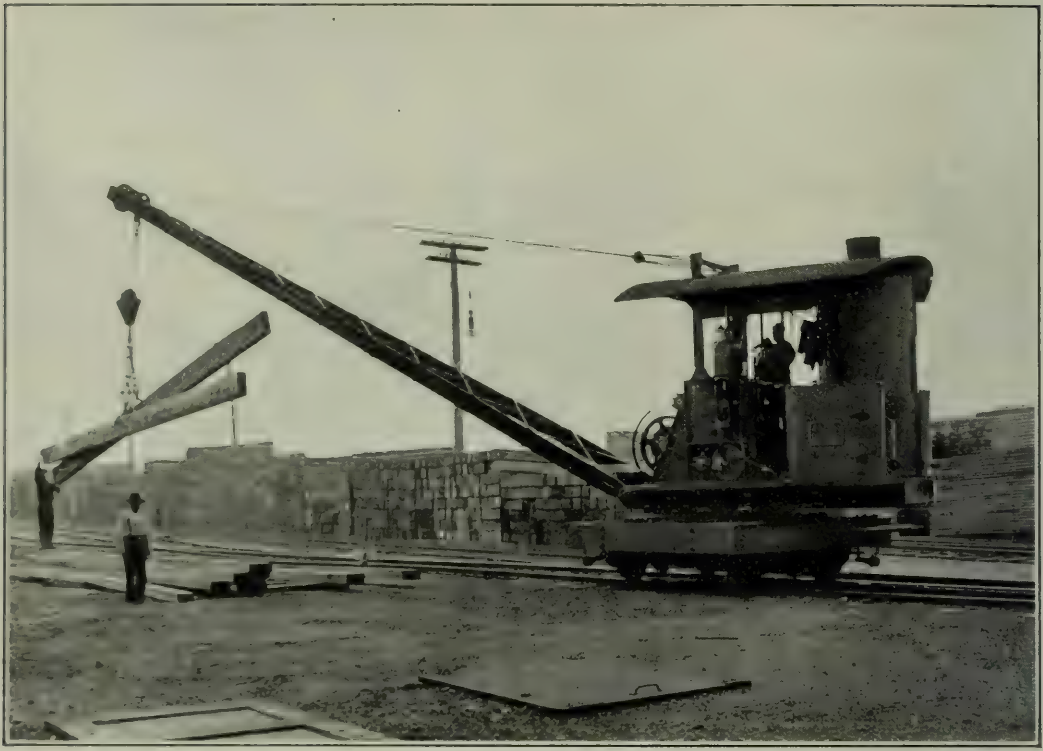
The paint and oil barrels are placed on large benches high enough to raise the barrel gates above the cans. Over these are arranged shelves for the smaller casks and cans and miscellaneous supplies, such as putty, paints, glass, lamp black, etc. No one is allowed to enter this building after dark with any kind of a light except incandescent lamps, which are arranged on extension cords with fuse rosette outside the building.

A PORTION OF THE CASTINGS STORAGE YARD.

All castings of like nature are piled together, in rows wide enough to permit handling the heavier ones with hand trucks.

The yard for the storage of materials which are not damaged by exposure to the weather is located on one side of the main stock building, and extends about twice its length. The one end is enclosed by a high fence and a storage thus provided for the smaller castings and parts, which are arranged in rows laid on boards far enough apart to allow the heavier ones to be handled with a truck. The castings that are liable to remain outside for some length of time are thoroughly cleaned and dipped in oil or painted, but little difficulty is experienced from this source, as the stock is kept as low as possible and on the move all the time.

There are also stored inside this fence such miscellaneous building supplies as are occasionally needed, as, for example, brick, tile, etc. The rest of the storage yard is set aside for the rough castings and



ONE OF THE LOCOMOTIVE CRANES IN THE STORAGE YARD.
A cheap and effective method of handling and storing lumber and heavy castings.

finished parts too heavy to be handled by hand, and is provided with a Browning No. 2 locomotive crane, as shown in the accompanying photograph, running on a standard-gauge track on each side of the yard. The locomotive crane is admitted to be the most efficient method of handling stores, for it not only can load and unload the cars but can be used as a shifting engine for transferring them from one place to another, and when provided with a bucket and operating mechanism can unload coal, ore, sand, and cinders and deposit the material 40 to 50 feet on either side of the track.

At one side of the yard nearest the proposed foundry is a long building, divided by partitions into small rooms for the storage of turnings, borings, cast scrap, punchings and clippings, brass, and copper, each material being kept entirely separate and protected from all other materials required by a foundry.

It was understood from the first that it would be practically impossible to store all of the material used throughout the entire plant in the one place, as the cost of rehandling some of it would amount to considerably more than the advantage gained, while the mere insignificance of others would not pay for the trouble. So while the general stores keeper is held responsible for *all* material used in the works, yet it is necessary in some cases that material be delivered to a department and a report of it made to him when used. The coal is delivered direct to the power house, the smithing coal to the smith shop, and the coke to the smith and structural shops, and the whole amounts charged up at once.

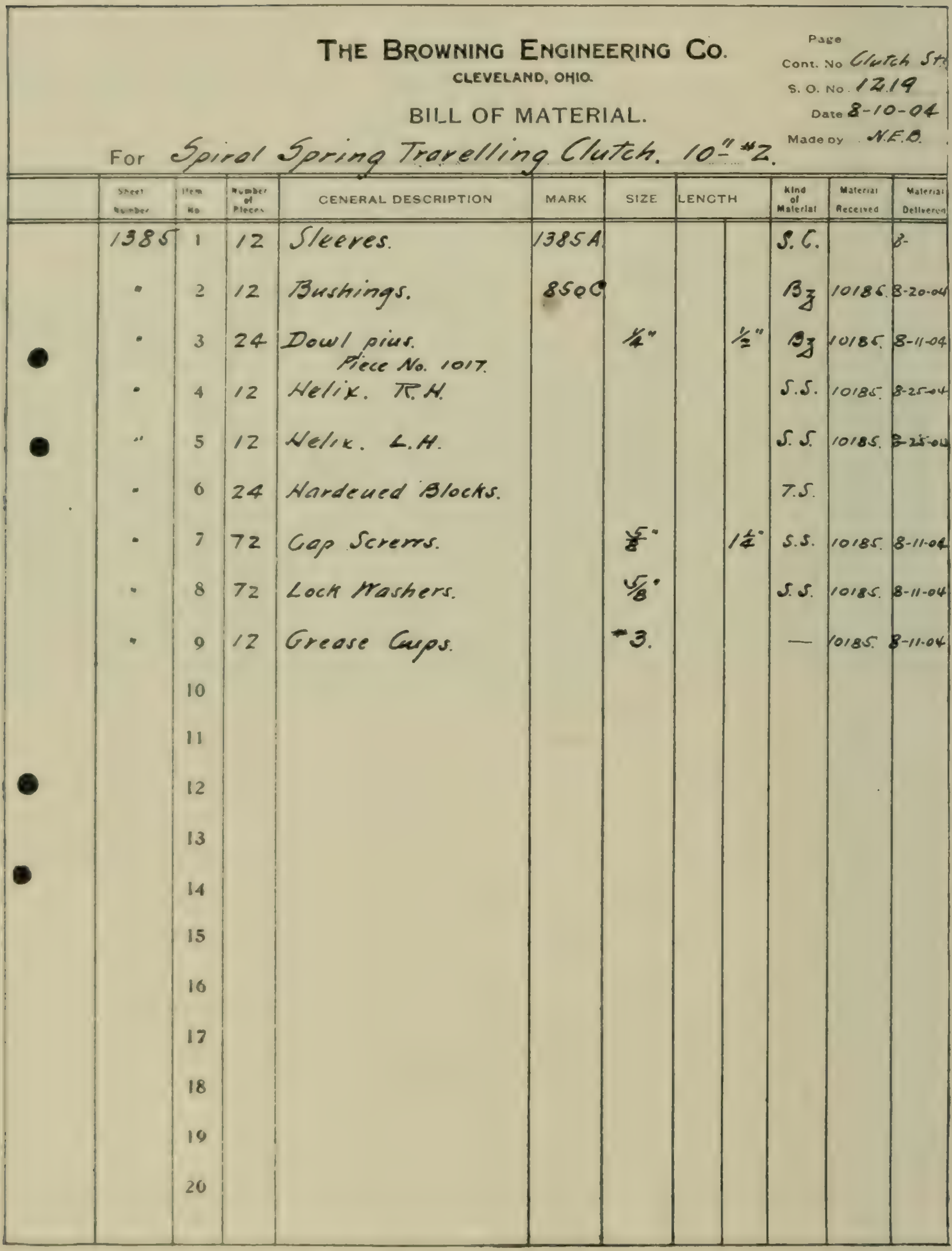
The pattern lumber is delivered direct to the dry kilns, and the carpenter material direct to the lumber storage, but a daily account is rendered to the general stores keeper of amounts used.

All the structural material, such as beams, channels, angles, and plates, is stored near one end of the structural shop and handled by the locomotive crane. The foreman of the department makes a daily report of all material used. The rivets, however, are kept in the general store house and are reserved for each order.

The small shop supplies, such as files, emery-paper, chalk, candles, and waste, are given out at the general tool room by order of the foreman, and are charged to his department and a report made daily to the general stores keeper. The office and drafting-room stores are kept in locked cases in the office building, in charge of an office clerk. All stationery, catalogues, envelopes, stamps, etc., are delivered to the stenographers in lots of 50 to 100 as desired. The drawing-paper, tracing cloth, ink, pencils, etc., are delivered to the draftsmen as needed. At the end of each month a report is made to the general store keeper, who makes the proper charges.

The System in Detail.—In all well managed concerns, the orders to begin the manufacture of each article or articles issue from the management and are necessitated by the nature of articles sold or in anticipation of sales. The quantity in which they are ordered depends entirely upon the nature of the product and is based upon: (1) the promised delivery of the articles sold; (2) the probable demand anticipated for any certain length of time; and (3) the measures necessary to avoid a loss of efficiency by a congested condition of any department in the manufacturing.

In The Browning Engineering Company, the orders for parts of machines to be built are fixed by mutual consent of the administrative, sales, and works management, and a copy of the signed agreement is kept by the works manager who issues a card 3 inches by 5 inches, to the engineering, billing, time-keeping, and stock departments, notifying them that certain shop orders have been taken out to build certain new parts. If the order requires the preparation of new designs and drawings, the engineering department is furnished with copies of all necessary information, and as soon as possible it furnishes to the billing and blue-print departments all new drawings



THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.

BILL OF MATERIAL.

Page
Cont. No Clutch St
S. O. No. 1219
Date 8-10-04
Made by N.E.B.

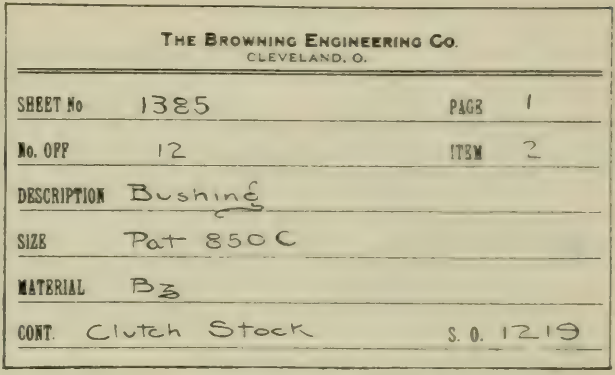
For Spiral Spring Travelling Clutch. 10" #2.

	Sheet Number	Item No	Number of Pieces	GENERAL DESCRIPTION	MARK	SIZE	LENGTH		Kind of Material	Material Received	Material Delivered
	1385	1	12	Sleeves.	1385A				S. C.		8-
	"	2	12	Bushings.	850C				Bz	10186.	8-20-04
	"	3	24	Dowl pins. Piece No. 1017.		1/4"		1/2"	Bz	10185.	8-11-04
	"	4	12	Helix. R.H.					S.S.	10185.	8-25-04
	"	5	12	Helix. L.H.					S. S.	10185.	8-25-04
	"	6	24	Hardened Blocks.					T.S.		
	"	7	72	Cap Screws.		5/8"		1¼"	S.S.	10185.	8-11-04
	"	8	72	Lock Washers.		5/8"			S. S.	10185.	8-11-04
	"	9	12	Grease Cups.		#3.			—	10185.	8-11-04
		10									
		11									
		12									
		13									
		14									
		15									
		16									
		17									
		18									
		19									
		20									

THE BILL OF MATERIAL.

This is furnished by the billing department, and contains an itemized list of all the parts necessary to make up the order. A copy is sent to the foreman of each department and is not withdrawn until the order is completed ready for shipment.

complete, with memorandum of old ones to be used. If, however, the order is to be an exact duplicate of one previously built, the billing department is able to proceed at once, and from the tracing and blue prints a complete "bill of material" of every piece used is written with hektograph ink and copies furnished to the foreman



THE BROWNING ENGINEERING CO.
CLEVELAND, O.

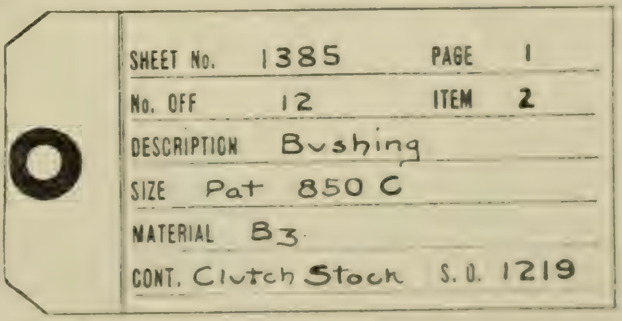
SHEET No 1385 PAGE 1
No. OFF 12 ITEM 2
DESCRIPTION Bushing
SIZE Pat 850 C
MATERIAL B3
CONT. Clutch Stock S. O. 1219

THE FOLLOW CARD.

It contains the same information as the tag, and is forwarded from one foreman to another as the work progresses. Half the size of original.

of each department. This bill is not only an official general order, but in such detailed form that every single article used is listed out. The bill of material contains all the information that can possibly be given in writing, as shown by the accompanying cut. For each item there is provided by the billing department a "Tag," which is made of heavy linen, reinforced around the hole in one end, made out with water-proof ink as shown, to be fastened to the work while in process of manufacturing, and a "follow card," which is a 3 inches by 5 inches ordinary index card, which follows the work from department to department and is kept in drawers on the desks of the respective foremen in whose departments the pieces lie.

All these tags and follow cards are first sent to the general stores-keeping department, where they are sorted and filed; from the records, a list is made of all material needed to fill the order, and this list in the form of a requisition is then sent to the office of the works manager, and (when authorized) to the purchasing agent, who as soon as it is decided where to purchase the articles writes out an order in quadruplicate. The original order is sent to the firm from whom the goods are purchased; two copies remain with the purchasing agent, one filed numerically, the other alphabetically; while the fourth copy goes to the general stores keeper, to identify the material when it arrives. The order is shown on page 374.

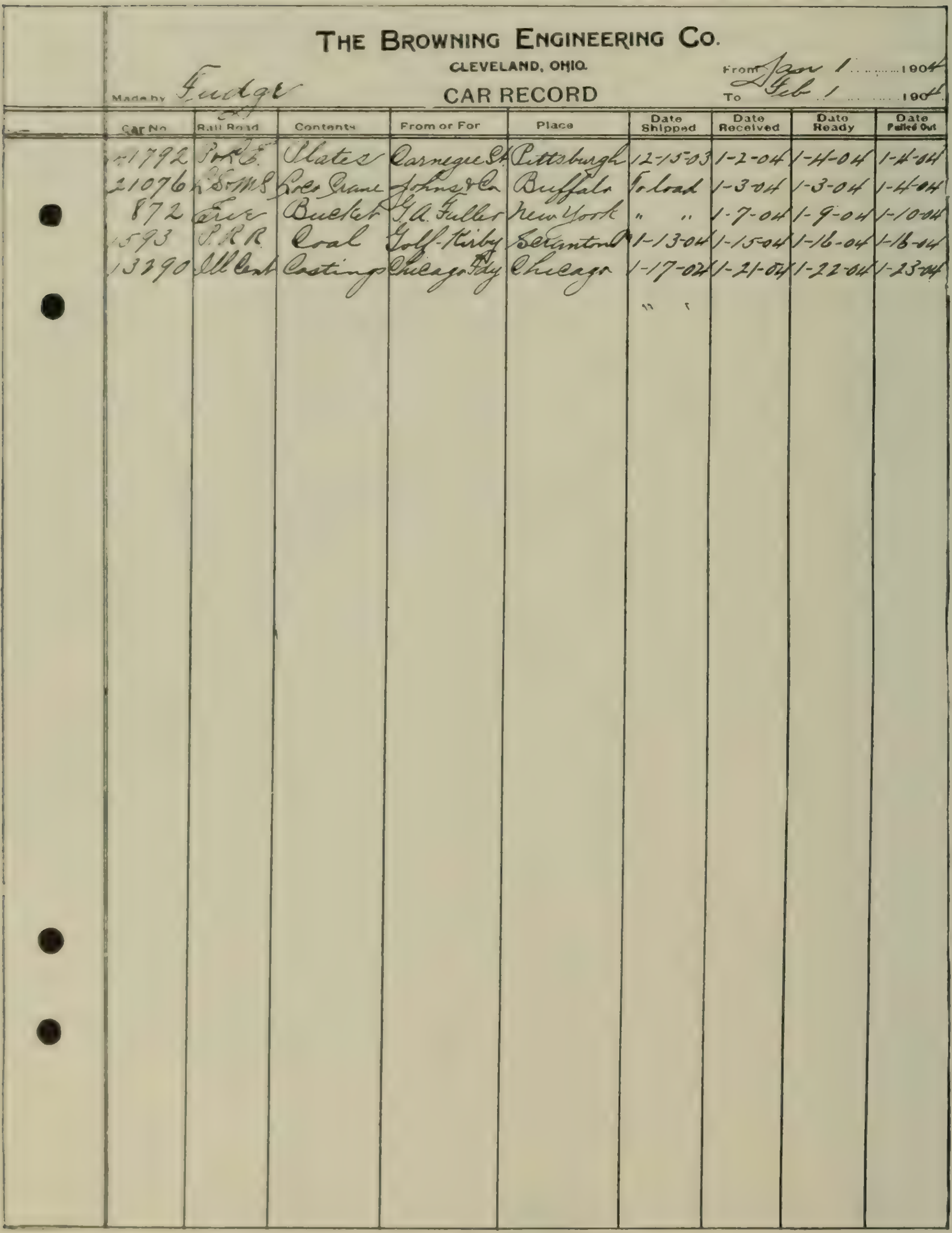


SHEET No. 1385 PAGE 1
No. OFF 12 ITEM 2
DESCRIPTION Bushing
SIZE Pat 850 C
MATERIAL B3
CONT. Clutch Stock S. O. 1219

THE TAG.

Furnished by the billing department for each lot of articles, and attached to one piece of the lot. Twice this size, made of linen and printed in water proof ink.

The responsibility of the general stores keeper begins with the placing of the order. He has all the teams and wagons at his disposal, and uses his own judgment in sending for materials purchased of local dealers. He keeps a



THE BROWNING ENGINEERING CO.

CLEVELAND, OHIO.

Made by Fudge

CAR RECORD

From Jan 1 1904

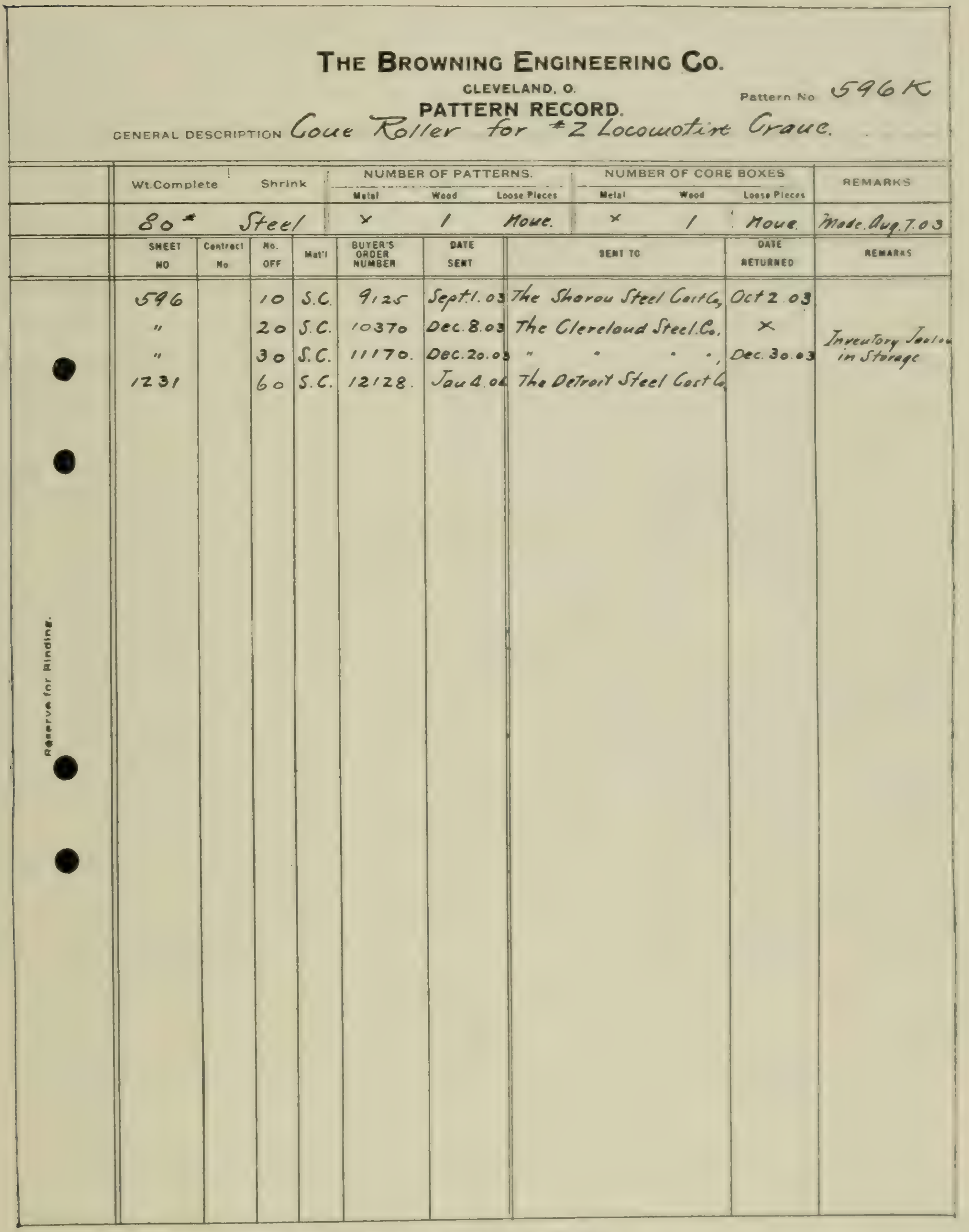
To Feb 1 1904

Car No	Rail Road	Contents	From or For	Place	Date Shipped	Date Received	Date Ready	Date Pulled Out
1792	P&LE	Plates	Carnegie St.	Pittsburgh	12-15-03	1-2-04	1-4-04	1-4-04
21076	L.S.M.S.	Loco Crane	Johns & Co	Buffalo	To load	1-3-04	1-3-04	1-4-04
872	Erie	Bucket	G.A. Fuller	New York	" "	1-7-04	1-9-04	1-10-04
593	P.R.R.	Coal	Golf-Kirby	Scranton	1-13-04	1-15-04	1-16-04	1-16-04
13790	Ill Cent	Castings	Chicago Fdy	Chicago	1-17-04	1-21-04	1-22-04	1-23-04

THE CAR RECORD.

This record is kept by the general stores keeper, and shows all cars shipped, received, loaded or unloaded, and pulled out. This is quite an assistance in settling demurrage claims.

car record of all cars shipped, and, when they arrive, the exact time unloaded and delivered to the railroad as well. He also has a record of all the patterns, so that the orders for castings may be placed more intelligently, and when it is necessary to move them from one foundry to another he may assist.



THE BROWNING ENGINEERING CO.
CLEVELAND, O.
PATTERN RECORD.
Pattern No 596 K
GENERAL DESCRIPTION Cone Roller for #2 Locomotive Crane.

	Wt. Complete	Shrink	NUMBER OF PATTERNS.			NUMBER OF CORE BOXES			REMARKS
			Metal	Wood	Loose Pieces	Metal	Wood	Loose Pieces	
	80#	Steel	×	1	None.	×	1	None.	Made Aug. 7. 03

	SHEET NO	Contract No	No. OFF	Mat'l	BUYER'S ORDER NUMBER	DATE SENT	SENT TO	DATE RETURNED	REMARKS
	596		10	S.C.	9125	Sept. 1. 03	The Sharon Steel Cast Co,	Oct 2. 03	
	"		20	S.C.	10370	Dec. 8. 03	The Cleveland Steel Co.	×	Inventory Taken in Storage
	"		30	S.C.	11170.	Dec. 20. 03	" " " "	Dec. 30. 03	
	1231		60	S.C.	12128.	Jan 4. 04	The Detroit Steel Cast Co		

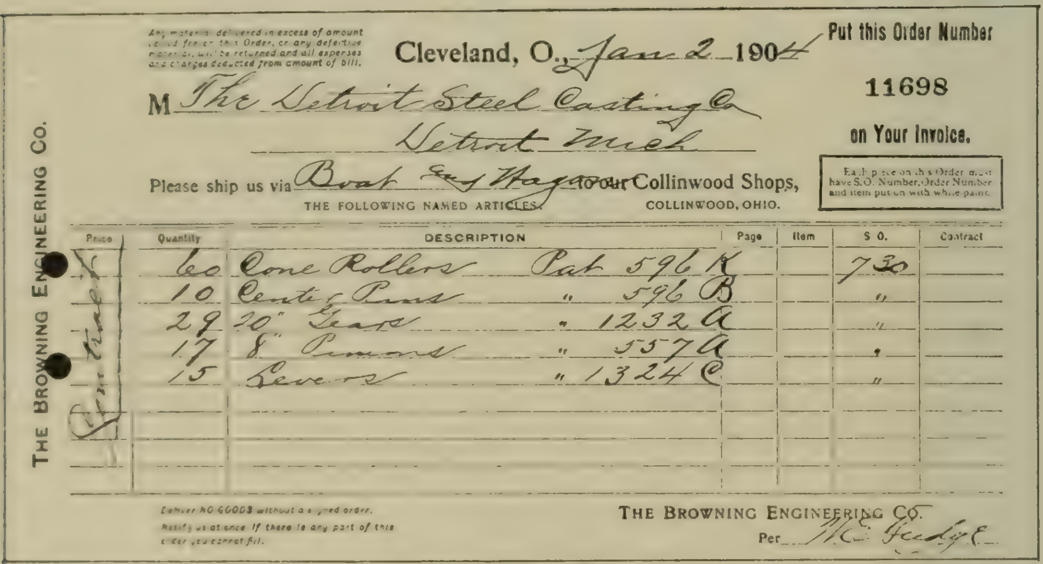
Reserve for Binding.

THE PATTERN RECORD.

A record of all patterns is kept by the general stores keeper to assist him in placing orders for castings when they are purchased outside. And transfer or change made by the pattern department is reported on a standard sheet made for the purpose.

Besides the orders which are kept on file until filled, a perpetual shortage list is carried at all times, of material ordered but not received. Copies of these are furnished to the works manager, the purchasing agent, and the outside inspectors of materials.

For convenience all materials purchased are charged to one of a division of accounts classified as nearly as possible by the department in which it is used. When the delivery is made to some live shop order, the account from which it is delivered is credited with the amount. At the end of each month the total purchased of each kind is added to that on hand at the first of the same month, and the amount delivered subtracted from this total. This gives the value of that remaining, which is recorded on the form shown opposite and is verified by an actual count once a year so that no mistakes nor errors caused by fluctuation of prices may be carried over to the next year. The yearly inventory, which includes not only the stores but every thing of value in the entire plant, is preserved in permanent form as illustrated by the reproduction on page 377.



THE BROWNING ENGINEERING CO.

Any material delivered in excess of amount called for on this Order, or any defective material, will be returned and all expenses and charges deducted from amount of bill.

Cleveland, O., Jan 2 1904

Put this Order Number
11698
on Your Invoice.

M The Detroit Steel Casting Co
Detroit Mich

Please ship us via Boat or Wagon ~~to our~~ Collinwood Shops, THE FOLLOWING NAMED ARTICLES. COLLINWOOD, OHIO.

Each piece on this Order must have S.O. Number, Order Number and item put on with white paint.

Price	Quantity	DESCRIPTION	Page	Item	S. O.	Contract
X	60	Cone Rollers Pat 596 K			730	
	10	Center Pins " 596 B			"	
	29	20" Gears " 1232 A			"	
	17	8" Pinions " 557 A			"	
	15	Levers " 1324 C			"	

Deliver NO GOODS without a signed order.
Notify us at once if there is any part of this order you cannot fill.

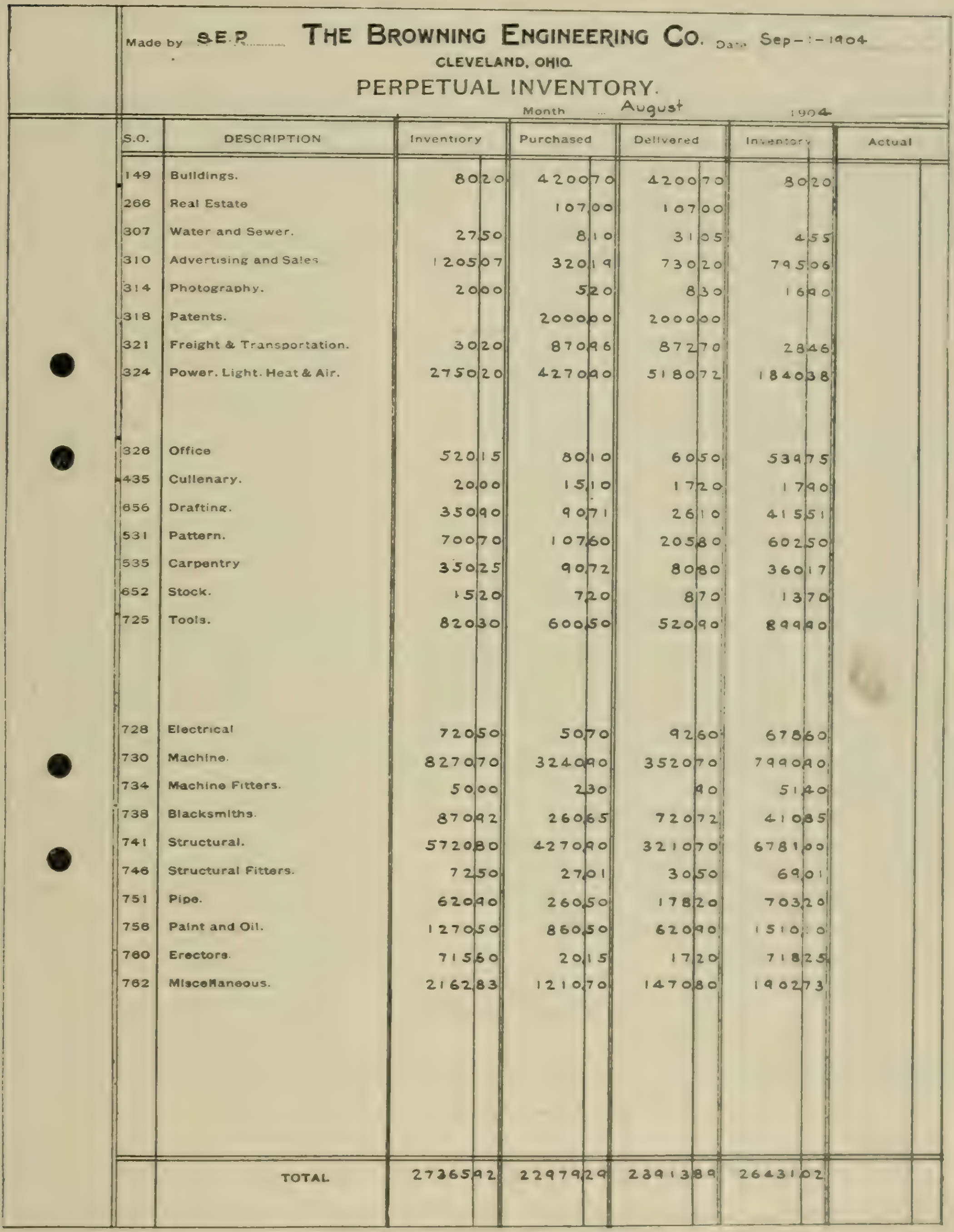
THE BROWNING ENGINEERING CO.
Per

PURCHASERS' ORDER.

This order is made out in quadruplicate by the purchasing agent, from the requisition of general stores keeper; two copies remain with him, and are filed numerically and alphabetically; a third copy is sent to the general stores keeper. Original is twice this size, thin white paper.

The material received, after being carefully weighed, counted, measured, inspected, and accepted, is recorded daily on a form for the purpose as shown on page 378. The original is sent to the office to assist in correctly checking and auditing the accounts, while the carbon copy remains with the general stores keeper for reference.

The material that is in stock when the tags are received is at once "reserved" for the order; the material that must be purchased, as soon as it arrives. The proper amounts of the smaller articles, such as nuts, bolts, screws, washers, pipe fittings, etc., after being tied up in a neat bundle by the stock clerks and the tag attached, are placed



Made by S.E.P. **THE BROWNING ENGINEERING CO.** Date Sep-1-1904

CLEVELAND, OHIO.

PERPETUAL INVENTORY.

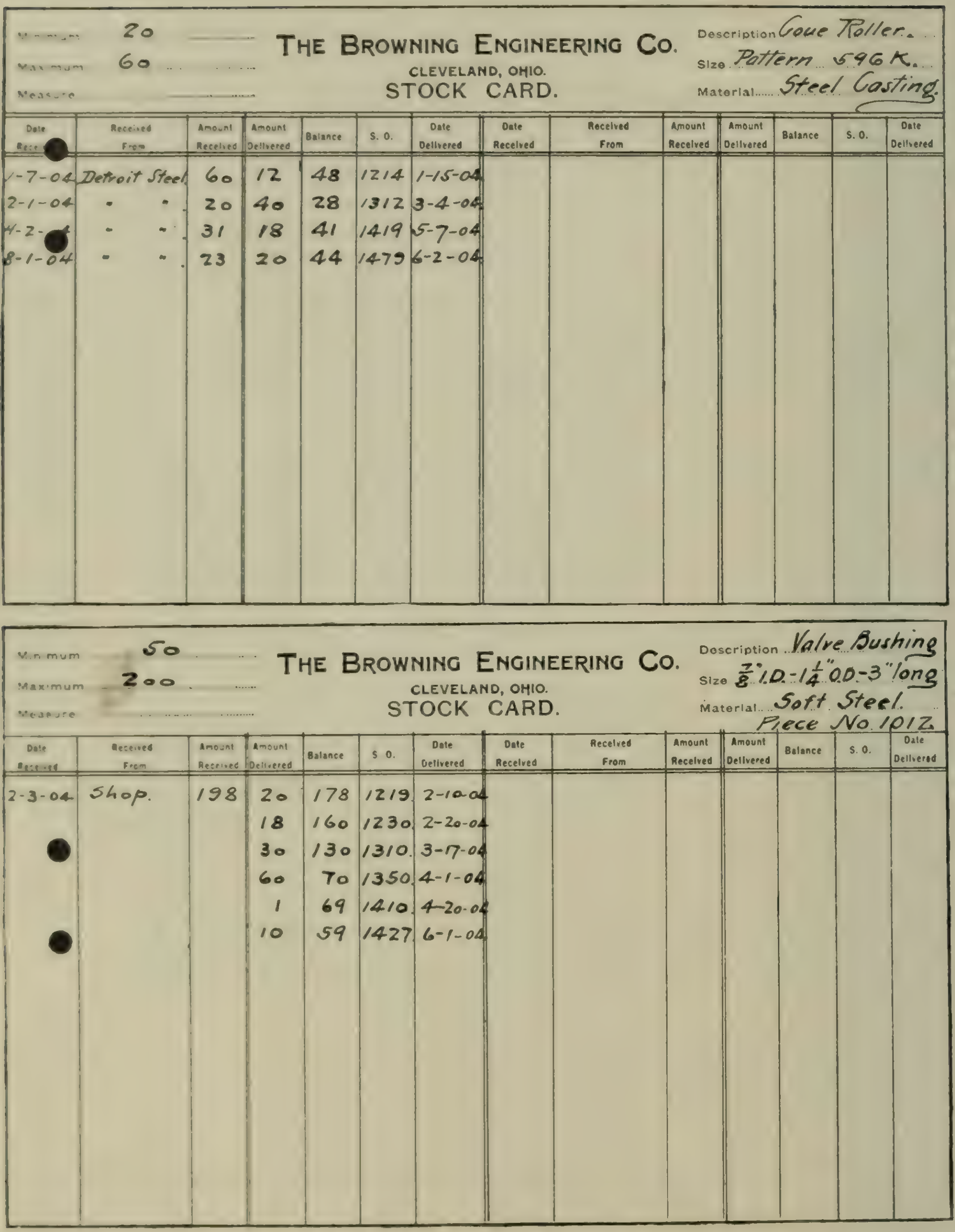
Month August 1904

S.O.	DESCRIPTION	Inventiory		Purchased		Delivered		Inventory		Actual	
149	Buildings.	80	20	4200	70	4200	70	80	20		
266	Real Estate			107	00	107	00				
307	Water and Sewer.	27	50	8	10	31	05	4	55		
310	Advertising and Sales	1205	07	320	19	730	20	795	06		
314	Photography.	20	00	5	20	8	30	16	90		
318	Patents.			2000	00	2000	00				
321	Freight & Transportation.	30	20	870	96	872	70	28	46		
324	Power. Light. Heat & Air.	2750	20	4270	90	5180	72	1840	38		
326	Office	520	15	80	10	60	50	539	75		
435	Cullenary.	20	00	15	10	17	20	17	90		
656	Drafting.	350	90	90	71	26	10	415	51		
531	Pattern.	700	70	107	60	205	80	602	50		
535	Carpentry	350	25	90	72	80	80	360	17		
652	Stock.	15	20	7	20	8	70	13	70		
725	Tools.	820	30	600	50	520	90	899	90		
728	Electrical	720	50	50	70	92	60	678	60		
730	Machine.	8270	70	3240	90	3520	70	7990	90		
734	Machine Fitters.	50	00	2	30		90	51	40		
738	Blacksmiths.	870	92	260	65	720	72	410	85		
741	Structural.	5720	80	4270	90	3210	70	6781	00		
746	Structural Fitters.	72	50	27	01	30	50	69	01		
751	Pipe.	620	90	260	50	178	20	703	20		
756	Paint and Oil.	1270	50	860	50	620	90	1510	10		
760	Erectors.	715	60	20	15	17	20	718	25		
762	Miscellaneous.	2162	83	1210	70	1470	80	1902	73		
	TOTAL	27365	92	22979	29	23913	89	26431	02		

THE PERPETUAL INVENTORY.

This perpetual inventory of crude stock is compiled monthly (or oftener if desirable), from delivery cards, and shows the quantity of each class of material purchased, delivered, and stock on hand.

in one of the bins assigned to the order in the reserved stock room. The castings required are removed from the storage to a reserved space near the machine shop from whence they may be delivered to the machines when these are ready to begin work upon them. In addition to attaching the tag, the shop order number is painted on



Minimum 20
Maximum 60
Measure

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.
STOCK CARD.

Description Coue Roller.
Size Pattern 596 K.
Material Steel Casting.

Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered	Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered
1-7-04	Detroit Steel	60	12	48	1214	1-15-04							
2-1-04	" "	20	40	28	1312	3-4-04							
4-2-04	" "	31	18	41	1419	5-7-04							
8-1-04	" "	23	20	44	1479	6-2-04							

Minimum 50
Maximum 200
Measure

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.
STOCK CARD.

Description Valve Bushing
Size $\frac{7}{8}$" I.D.-1$\frac{1}{4}$" O.D.-3" long
Material Soft Steel.
Piece No. 1012.

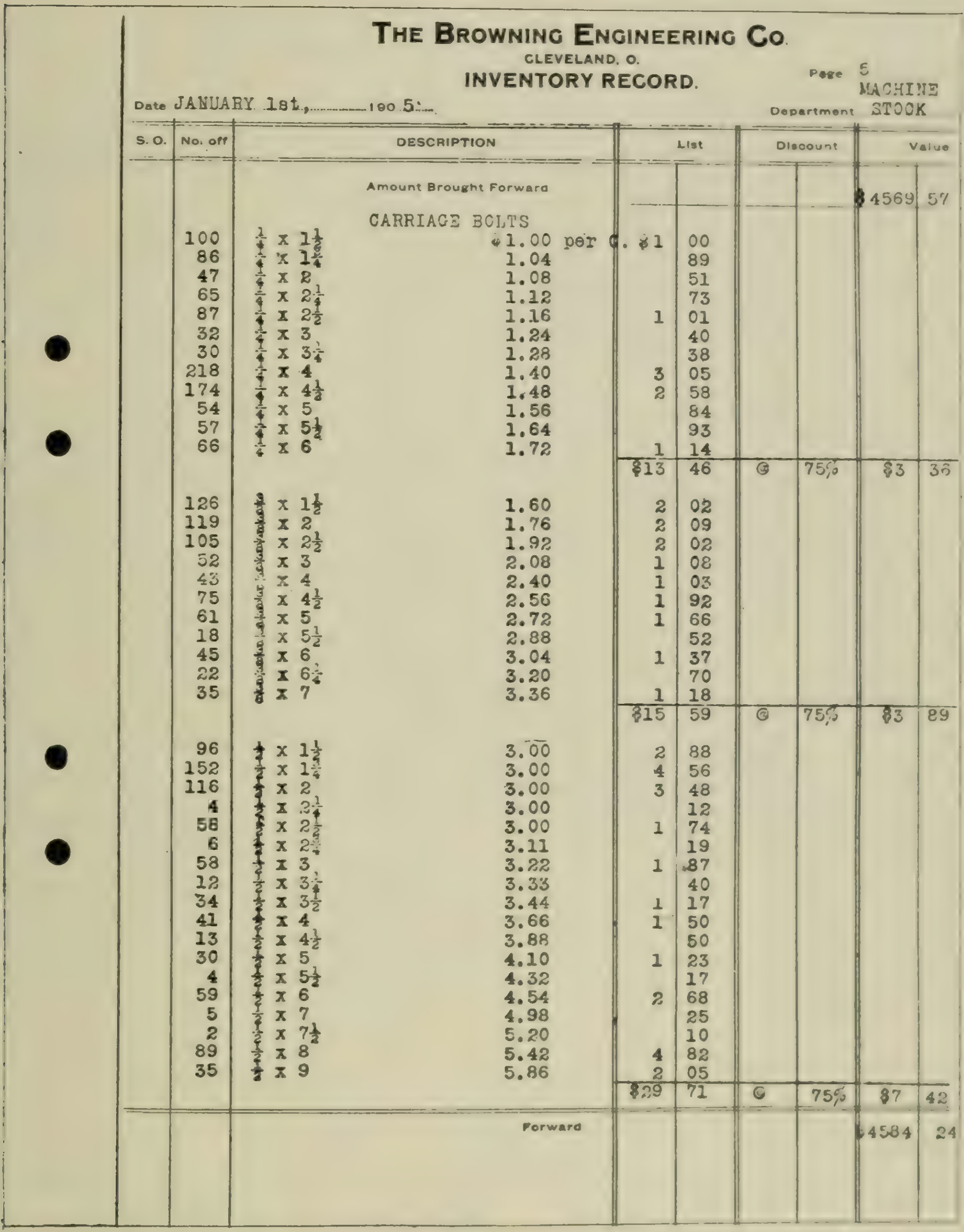
Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered	Date Received	Received From	Amount Received	Amount Delivered	Balance	S. O.	Date Delivered
2-3-04	Shop.	198	20	178	1219	2-10-04							
			18	160	1230	2-20-04							
			30	130	1310	3-17-04							
			60	70	1350	4-1-04							
			1	69	1410	4-20-04							
			10	59	1427	6-1-04							

EXAMPLES OF STOCK CARDS.

These cards are used by the general stores keeper in keeping a record of material. The upper one is filled out as applied to castings, the lower one as applied to manufactured parts in stock.

each casting with white lead, and if possible where it will not be machined off.

The tags for forgings are at once forwarded to the smith shop, which orders suitable stock for the work and makes a report of rough and finished weights of material used when they are delivered



THE BROWNING ENGINEERING CO.
CLEVELAND, O.
INVENTORY RECORD.

Page 5
Date JANUARY 1st, 1905.
Department MACHINE STOCK

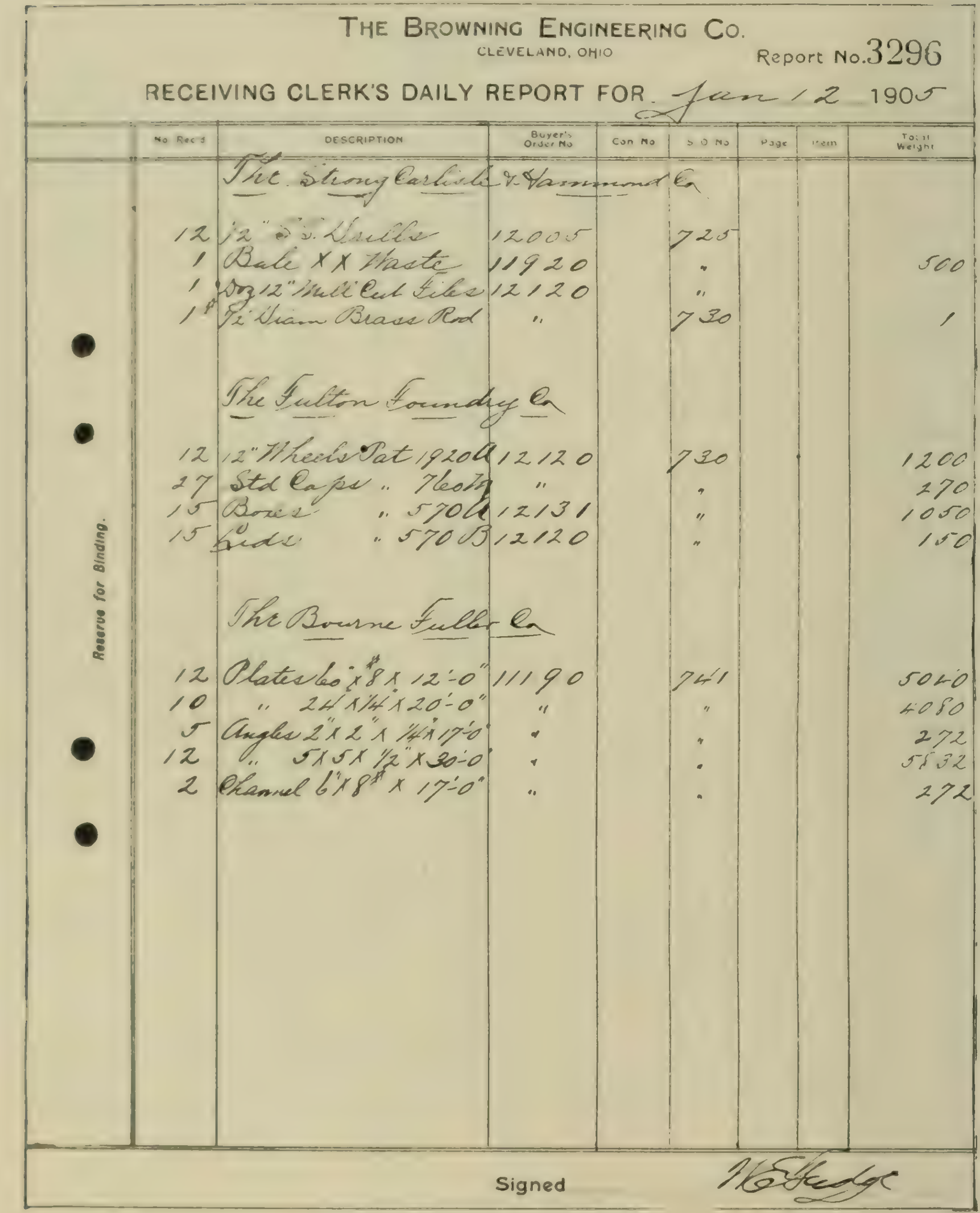
S. O.	No. off	DESCRIPTION		List		Discount		Value	
		Amount Brought Forward						$4569	57
		CARRIAGE BOLTS							
	100	¼ x 1½	$1.00 per C.	$1	00				
	86	¼ x 1¾	1.04		89				
	47	¼ x 2	1.08		51				
	65	¼ x 2¼	1.12		73				
	87	¼ x 2½	1.16	1	01				
	32	¼ x 3	1.24		40				
	30	¼ x 3¼	1.28		38				
	218	¼ x 4	1.40	3	05				
	174	¼ x 4½	1.48	2	58				
	54	¼ x 5	1.56		84				
	57	¼ x 5½	1.64		93				
	66	¼ x 6	1.72	1	14				
				$13	46	@	75%	$3	36
	126	⅜ x 1½	1.60	2	02				
	119	⅜ x 2	1.76	2	09				
	105	⅜ x 2½	1.92	2	02				
	52	⅜ x 3	2.08	1	08				
	43	⅜ x 4	2.40	1	03				
	75	⅜ x 4½	2.56	1	92				
	61	⅜ x 5	2.72	1	66				
	18	⅜ x 5½	2.88		52				
	45	⅜ x 6	3.04	1	37				
	22	⅜ x 6¼	3.20		70				
	35	⅜ x 7	3.36	1	18				
				$15	59	@	75%	$3	89
	96	½ x 1½	3.00	2	88				
	152	½ x 1¾	3.00	4	56				
	116	½ x 2	3.00	3	48				
	4	½ x 2¼	3.00		12				
	58	½ x 2½	3.00	1	74				
	6	½ x 2¾	3.11		19				
	58	½ x 3	3.22	1	87				
	12	½ x 3¼	3.33		40				
	34	½ x 3½	3.44	1	17				
	41	½ x 4	3.66	1	50				
	13	½ x 4½	3.88		50				
	30	½ x 5	4.10	1	23				
	4	½ x 5½	4.32		17				
	59	½ x 6	4.54	2	68				
	5	½ x 7	4.98		25				
	2	½ x 7½	5.20		10				
	89	½ x 8	5.42	4	82				
	35	½ x 9	5.86	2	05				
				$29	71	@	75%	$7	42
		Forward						$4584	24

THE YEARLY INVENTORY.

This inventory is taken once a year by actual count and is valued at the market price January 1. This is used as a basis from which the perpetual inventory is derived.

to the next department. The material for the small duplicate work is delivered with the tags and cards direct to the screw machines, and the finished product, after being inspected, is returned to the reserve stock bins to await assembling.

The rough and drawn shafting is all cut to proper length with the ends centered and chamfered where required and delivered to



THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO
Report No. 3296

RECEIVING CLERK'S DAILY REPORT FOR Jan 12 1905

Reserve for Binding.

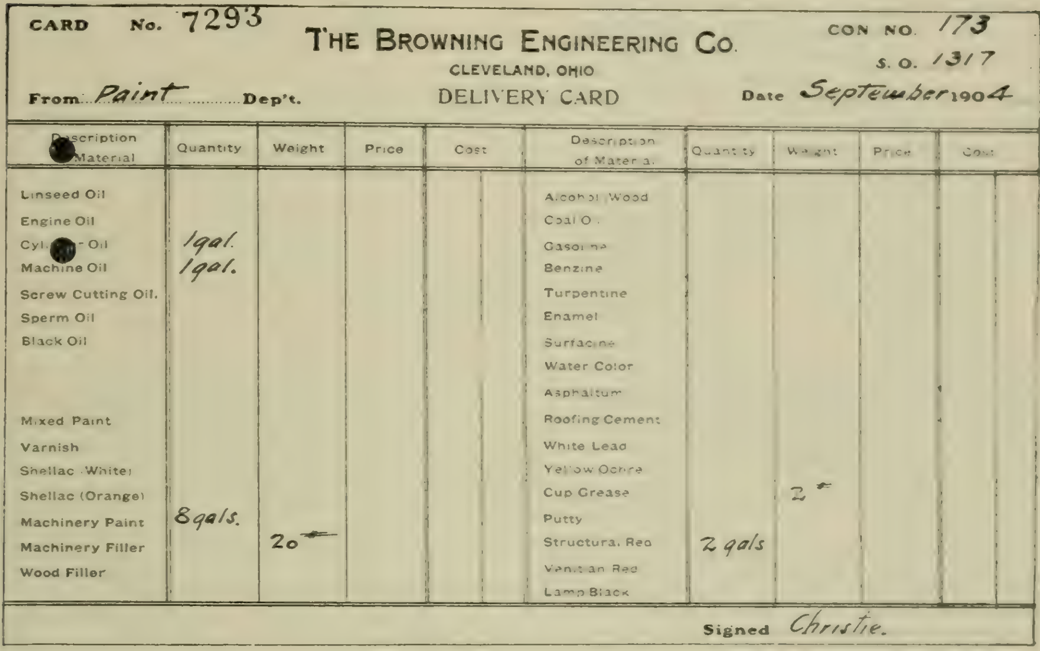
No. Rec'd	DESCRIPTION	Buyer's Order No.	Con. No.	S. O. No.	Page	Item	Total Weight
	The Strong Carlisle & Hammond Co						
12	12" S.S. Drills	12005		725			
1	Bale XX Waste	11920		"			500
1	Doz 12" Mill Cut Files	12120		"			
1#	1/2" Diam Brass Rod	"		730			1
	The Fulton Foundry Co						
12	12" Wheels Pat 1920A	12120		730			1200
27	Std Caps " 760A	"		"			270
15	Boxes " 570A	12131		"			1050
15	Lids " 570B	12120		"			150
	The Bourne Fuller Co						
12	Plates 60" x 8# x 12'-0"	11190		741			5040
10	" 24" x 1/4" x 20'-0"	"		"			4080
5	Angles 2" x 2" x 1/4" x 17'-0"	"		"			272
12	" 5 x 5 x 1/2" x 30'-0"	"		"			5832
2	Channel 6" x 8# x 17'-0"	"		"			272

Signed W E Hedge

RECEIVING CLERK'S DAILY REPORT.

This report is made out daily by the general stores keeper, showing the material received, from whom received, number, size, weight, etc., so that all invoices may be intelligently checked by the auditing and cost departments.

the machine or fitting departments with tag attached. To further identify it, the shop order and sheet number is stamped on the end of each piece. All of the pipe is cut to suit the fittings by the operator of the cutting-off machines and placed in the reserve stock room with tags attached. The rivets are counted out and reserved in kegs for



CARD No. 7293

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO
DELIVERY CARD

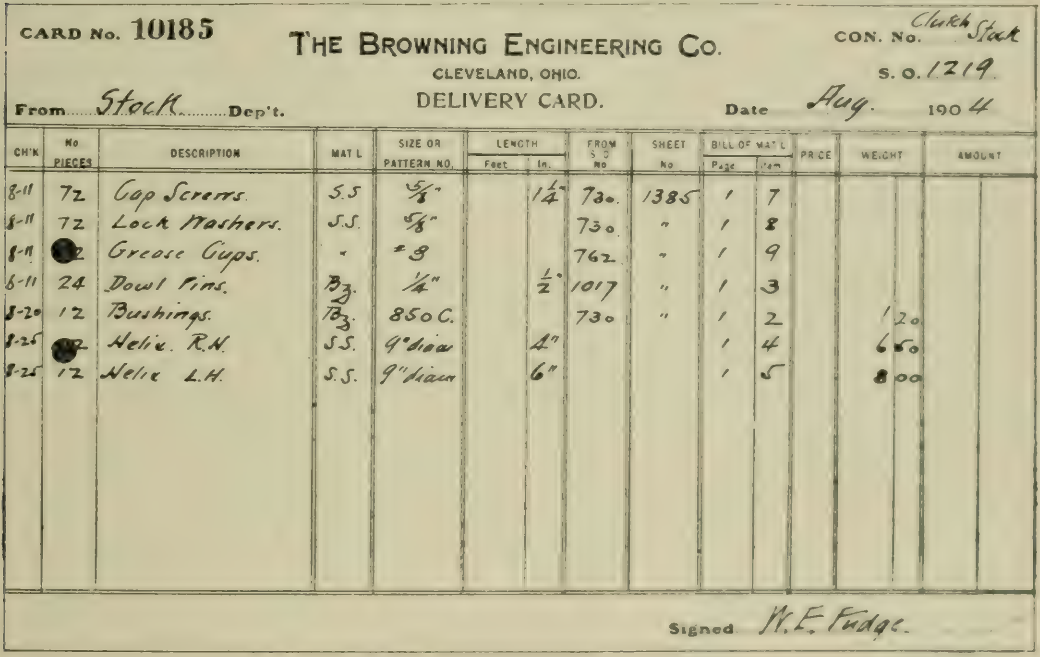
CON NO. 173
S. O. 1317

From Paint Dep't.

Date September 1904

Description [illegible] Material	Quantity	Weight	Price	Cost	Description of Material	Quantity	Weight	Price	Cost
Linseed Oil					Alcohol Wood				
Engine Oil					Coal Oil				
Cyl[illegible]r Oil	1 gal.				Gasoline				
Machine Oil	1 gal.				Benzine				
Screw Cutting Oil.					Turpentine				
Sperm Oil					Enamel				
Black Oil					Surfacine				
					Water Color				
					Asphaltum				
Mixed Paint					Roofing Cement				
Varnish					White Lead				
Shellac (White)					Yellow Ochre				
Shellac (Orange)					Cup Grease		2#		
Machinery Paint	8 gals.				Putty				
Machinery Filler		20#			Structural Red	2 gals			
Wood Filler					Venetian Red				
					Lamp Black				

Signed Christie.



CARD No. 10185

THE BROWNING ENGINEERING CO.
CLEVELAND, OHIO.
DELIVERY CARD.

CON. No. Clutch Stock
S. O. 1219.

From Stock Dep't.

Date Aug. 1904

CH'K	No PIECES	DESCRIPTION	MAT'L	SIZE OR PATTERN NO.	LENGTH Feet	LENGTH In.	FROM S. O. No	SHEET No	BILL OF MAT'L Page	BILL OF MAT'L Item	PRICE	WEIGHT	AMOUNT
8-11	72	Cap Screws.	S.S	5/8"		1¼"	730.	1385	1	7			
8-11	72	Lock Washers.	S.S.	5/8"			730.	"	1	8			
8-11	[illegible]	Grease Cups.	"	#3			762.	"	1	9			
8-11	24	Dowl Pins.	Bz.	¼"		½"	1017	"	1	3			
8-20	12	Bushings.	Bz.	850 C.			730	"	1	2		1 20	
8-25	[illegible]	Helix. R.H.	S.S.	9" diam		4"			1	4		6 50	
8-25	12	Helix L.H.	S.S.	9" diam		6"			1	5		8 00	

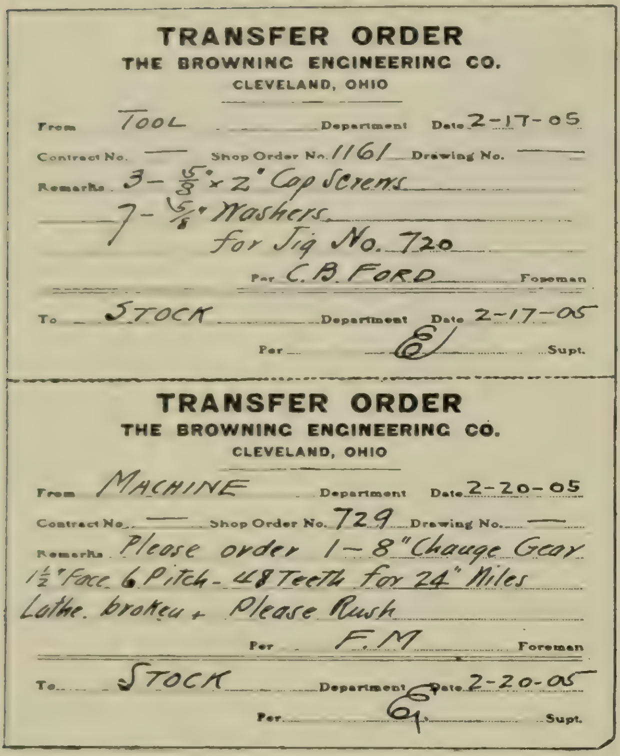
Signed W. E. Fudge.

SPECIMENS OF DELIVERY CARDS.

These cards are made by the general stores keeper and show the exact material used, which may or may not agree with the bill of material. They are delivered to cost-keeping department at end of each month.

the structural department, a certain amount being allowed for shrinkage caused by burnt or badly driven ones.

No material is delivered or reserved unless the full amount called for by the tag is on hand, and when it is delivered, entries are made in the general stores keepers bill of material, of the date, depart-



TRANSFER ORDER
THE BROWNINC ENCINEERING CO.
CLEVELAND, OHIO

From TOOL Department Date 2-17-05
Contract No. — Shop Order No. 1161 Drawing No. —
Remarks 3 - 5/8" x 2" Cap Screws
7 - 5/8" Washers
for Jig No. 720
Per C. B. FORD Foreman
To STOCK Department Date 2-17-05
Per Supt.

TRANSFER ORDER
THE BROWNINC ENCINEERING CO.
CLEVELAND, OHIO

From MACHINE Department Date 2-20-05
Contract No. — Shop Order No. 729 Drawing No. —
Remarks Please order 1 - 8" Change Gear
1½" Face 6 Pitch - 48 Teeth for 24" Niles
Lathe. broken + Please Rush
Per F. M Foreman
To STOCK Department Date 2-20-05
Per Supt.

TRANSFER ORDERS.

Used by all departments for getting stores not called for on the bill of material. A carbon copy is made and retained by the issuer of the order. Double this size, thin blue paper.

ment, and the number of the delivery card upon which the material is charged. Then the follow cards are forwarded to the foreman of departments where the material was delivered, and his bills of material dated. The material in the reserve stock room may be obtained at any time by any department upon presentation of their bills of material to be stamped by the stock clerk when the material is delivered. All orders for material built on stock, repairs, or direct for a customer follow the same general course.

In any system exceptions are sure to arise which it is practically impossible to whip into line. To meet these contingencies a tranfer order was devised as shown in accompanying cut. Each foreman carries a small book of these orders with him at all times, and all requisitions for repairs, replacements, new tools, exchanges, etc., are written by him and the original sent to the superintendent's office for authorization; the carbon copy remains in the book. The original is never accepted unless it bears the superintendent's signature. All material for new tools and work done on them in other departments are procured by means of these orders.

While there are innumerable little kinks and curls which intertwine themselves with the daily working of the system, it remains in the main as here set forth; and while conditions are continually causing minor changes, it has been found to meet most admirably the general requirements for which is was created.

UTILIZING THE POWER OF THE NIAGARA RAPIDS.

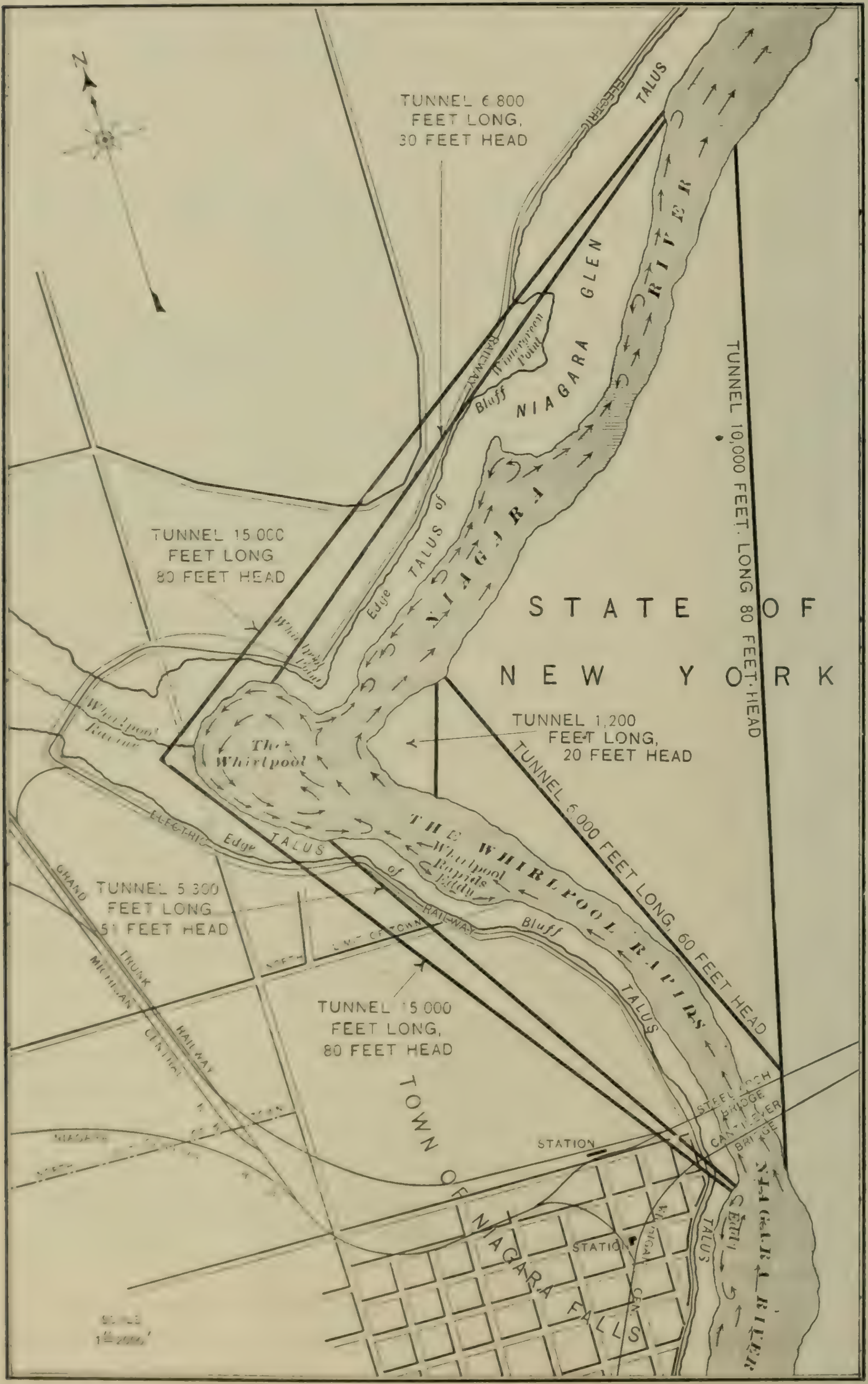
By Alton D. Adams.

Recent events have directed attention again to the heavy demands which are being made on Niagara Falls for power uses, and the menace of their serious impairment as a scenic feature. This is a possibility which none but a very few ultra-utilitarians would care to contemplate. Mr. Adams' paper is therefore of much interest in that it proposes a way by which the probably inevitable continuance of the power demands may be fully met with a minimum of loss to the natural beauty of the region.—THE EDITORS.

THE Niagara River descends 100 feet and develops 2,500,000 horse power between the base of the great cataract and the foot of the escarpment at Lewiston and Queenston, five miles down stream.

This energy, represented by the normal discharge of 222,000 cubic feet of water per second, is now expended in excavating the great gorge in which the White Horse Rapids, the Whirlpool, and Niagara Glen are located. Fully 80 feet of this fall along the rapids occurs between a point several hundred feet south of the Cantilever Bridge and another at the lower end of the glen, which can be connected by a tunnel some 10,000 feet long, on the New York side of the river. With the head of 80 feet and the discharge of 222,000 cubic feet per second, named above, these rapids thus develop 2,000,000 horse power, as mechanical motion and heat. This power is fully one-half as great as that of the American and Horse Shoe Falls combined, since the volume of water is substantially the same in the falls and the rapids, and the descent of the former is only twice that of the latter. Making the fair assumption that 60 per cent. of the gross energy in the water of these rapids can be transformed into electric current, the output of plants utilizing the entire flow would reach 1,200,000 horse power. This capacity is nearly double that of the six great electric power stations that are now in various stages of completion about Niagara Falls, three on the New York and three on the Canadian side of the river.

No great difficulty in the way of engineering appears to exist as to the development of the power of the rapids in the Niagara Gorge, either by means of tunnels or of a dam. The rock formation about the gorge is much like that at the falls, and the river just above



MAP OF THE NIAGARA RAPIDS AND THE POSSIBLE POWER TUNNELS.

Lewiston, where a dam might be located, flows between perpendicular walls of rock that are less than 1,000 feet apart.

If advantage is to be taken of the steeper parts of the rapids, both above and below the whirlpool, so as to obtain an operating head of not less than 80 feet of water by a tunnel, the intake end of the tunnel on the New York side of the Niagara River should be located beneath the water level at a point some 400 feet above the Cantilever Bridge, and the lower end should discharge into the gorge about 7,000 feet down stream from the whirlpool. A tunnel in a straight line between the openings just named would represent one side of a triangle, with the chains of rapids above and below the whirlpool respectively for the other two sides.

With the tunnel just suggested, the generating station might be located over a wheel pit at the intake end, as is the case with some of the existing plants, or at the discharge end in the gorge. In this latter case it might be desirable to lay a steel pipe line in the tunnel so that no forebay would be necessary at the lower end. The length of this tunnel, 10,000 feet, is not great enough to create an unduly large investment, and it is in fact only 2,564 feet longer than that which carries the tail water from the two largest plants on the New York side of the falls. As the head of water made available by this tunnel is only one-half of the height of the American Falls, the cross section of the proposed tunnel would probably be about twice as great per horse power of capacity as is the area in cross section of the existing tunnel of the Niagara Falls Power Company. This tunnel is 21 feet high, 18 feet 10 inches wide, and delivers the tail water from two generating stations that have a combined capacity of 105,000 electric horse power. As one of these stations utilizes only 136 feet of water head at its wheels, owing to the lack of draft tubes, the power capacity of this existing tunnel would be greater if the wheels that discharge into it operated under the full head afforded by the American Fall. Any disadvantage in the matter of first cost per horse power of capacity in the proposed tunnel along the rapids, due to the fact that the head thus made available would be limited to about 80 feet, is fully offset by the great cross-section and capacity that may be given to this tunnel. Each of the three great power tunnels that now pierce the cliffs about Niagara Falls has been limited in its capacity to correspond more or less nearly with the water rights of the company that built it. Thus the tunnel of the Niagara Falls Power Company is designed for a development of about 100,000, the tunnel of the Canadian Niagara Power Company for a development of about 110,000, and the tunnel of the Toronto Niagara Power Company for a development of about 117,000 horse power in electric generators. With sufficient water to develop 1,200,000 electric horse power under a head of 80 feet going down the rapids, there need be no such limitation as the figures just given on the capacity of a tunnel from the upper to the lower gorge. Such a tunnel might, in fact, be designed to suck down one-half the entire discharge of the river, and to deliver water for a power development that would equal the combined capacity of the six great hydro-electric plants now completed or under construction on both sides of the falls. A very large tunnel like that just suggested would cost less per horse power of capacity than have some of the smaller existing tunnels. Looking at a map of the Niagara River below the falls, it may be seen that the tunnel just suggested is shorter than any other tunnel or combination of tunnels that can be devised to render available an equal head of water in the rapids above and below the whirlpool. This is due to the alignments of the two main series of rapids, which are at right angles with each other, and have the whirlpool at the apex. Because of this formation of the river bed, New York State offers a more favorable site than Ontario for the transformation of the power of the rapids into electric energy. To obtain the same head of water on the Ontario side of the river, by a tunnel opening about 400 feet up stream from the Cantilever Bridge, and about 7,000 feet down stream from the whirlpool, the tunnel must pass the whirlpool by a change of about 90 degrees in direction, and have a length of about 15,000 feet, or 50 per cent. more than the length of a tunnel to develop a water power of equal head on the New York side.

While the power development just considered, with a tunnel whose intake is above the rapids and whose outlet is below, in the gorge, is more attractive than any other that is practicable on the lower river, because it offers the greatest head for anything like the same length of tunnel, it is by no means the only possible one there. In fact, there are numerous locations, both above and below the whirlpool, where hundreds of thousands of horse power may be developed under heads of 20 to 60 feet, with only moderate investments in plant construction. On the New York side of the river the great promontory of limestone and shale, that separates the rapids above from those below the whirlpool, might be pierced by an indefinite number of tunnels that would give heads of water roughly proportionate to their lengths.

One such tunnel piercing the promontory a few hundred feet back from its point at the whirlpool, and about 1,200 feet long, would develop a water head of about 20 feet. From a point 400 feet above the Cantilever Bridge, to the brink of the river 1,000 feet below the point of the New York promontory, the length of a tunnel substantially parallel with the whirlpool rapids would be about 6,000 feet, and this tunnel would maintain a water head of fully 60 feet.

Passing to the Ontario side of the river, where the utilization of the entire head of the rapids both above and below the whirlpool would require a rather long tunnel, it appears that several developments of lesser heads may be made with only moderate investments. For one of these the intake end of the tunnel would be located about 400 feet up stream from the Cantilever Bridge, and its vent would be at the upper side of the whirlpool, so that a head of about 51 feet would be obtained with a tunnel length of approximately 5,000 feet. This is one of the best sites for power development under moderate head in the gorge, and can be nearly duplicated on the opposite New York bank. The necessity for a tunnel instead of a canal in all of these cases is due to the fact that the perpendicular cliffs on either side of Niagara Gorge rise to a height of 200 feet or more above the water, so that an open canal is impracticable. From the lower side of the whirlpool, and beneath that part of the gorge known as Niagara Glen, where the distance between the high cliffs increases to several times the width of the river, and leaves a wide bench of talus next to the stream on the Canadian side, a tunnel 6,800 feet long will develop a water head of about 30 feet. In this case again a tunnel of about the length just named, running down stream from the whirlpool on the New York side of the river, would develop a head equal to that which could be maintained by a parallel tunnel on the Canadian side.

Each of the proposed developments of water power under heads of 20 to 60 feet, as named above, can be carried out at a moderate investment per horse power of capacity, but this cost per unit of capacity would necessarily be somewhat greater at each of the heads under 60 feet than under the head of at least 80 feet that might be developed by a 10,000 foot tunnel across the New York promontory. These tunnel developments do not, however, exhaust the possibilities of water-power plants in Niagara Gorge.

Dam Niagara, drown the White Horse Rapids, fill up the whirlpool, raise the water level in the gorge 100 feet, change the river into a storage reservoir from the foot of the cataract to the brow of the escarpment, and 1,500,000 electric horse power may be developed at Lewiston. When this power is not in use a third cataract will be created, with the combined discharge of both the American and the Horse Shoe Falls flowing over a dam 100 feet high between Lewiston and Queenston. At this dam fully 60 per cent. of the energy of 222,000 cubic feet of water per second falling 100 feet and developing 2,500,000 horse power may be transformed into electric current. If the question of power development at the escarpment was the only one to be considered, the dam at Lewiston might be 200 feet high without overflowing the sides of the gorge; but such a dam would raise the water basin at the foot of the American and Horse Shoe Falls 100 feet, thereby destroying these falls in a large degree, and also the value of the great generating stations that draw water from the upper river. A dam about 100 feet high, corresponding to the drop of the river surface from the foot of Niagara Falls to Lewiston, 5 miles below, would work no substantial injury either to the natural falls or the existing power plants.

On the other hand, the 100-foot dam at the brow of the escarpment would flood the rapids, and turn the whirlpool into a comparatively quiet body of water. As an offset to the loss of these scenic advantages, the proposed dam across the river just above Lewiston would develop a great power at a much lower cost per unit than can be effected with tunnels between different points in the gorge. The 1,500,000 horse power that might be developed by means of a dam 100 feet high at Lewiston is more than twice the capacity of all the hydro-electric plants now completed or in process of construction about Niagara Falls. As only a small fraction of the ultimate combined capacity of these plants is at present utilized, it seems that the additional development of 1,500,000 horse power at Lewiston, thus raising the total from Niagara River to more than 2,000,000 horse power, would provide all the energy that could be utilized within 300 miles of the falls in at least the next half-century.

The prospect of cheap electric energy is not only the inducement to the development of the above water powers in the gorge, either by means of tunnels through the cliffs or of a dam at Lewiston. A result of these developments on the lower river might well be to save from destruction that portion of the American Fall that has not already been granted away for power purposes. The demand for water rights at Niagara Falls is pressing hard for authority to dry up the American cataract, and Canada has taken advantge of the situation by leasing franchises that will yield more than $300,000 annually as water rent. Plants now partly completed on the Ontario side of the falls have the right to draw 32,000 cubic feet of water per second from the upper river, and an allowance of 3,000 feet per second for the Welland Canal raises the total there to 35,000 cubic feet per second. On the New York side of the falls, power plants completed or under construction have the right to suck down another 32,000 cubic feet of water per second, and this must be increased by 6,000 cubic feet for the Chicago Drainage Canal, and 1,200 cubic feet for the New York barge canal, a total in the United States of 39,200 cubic feet of water per second from the Great Lakes above the falls. The combined capacity of works already authorized on both sides of the lakes and river is thus not less than 74,200 cubic feet of water per second. This volume of water is 33 per cent. of the normal and 45 per cent. of the minimum discharge of Niagara River, and if its diversion above the falls does not entirely dry up the American cataract, this result will certainly be accomplished by a few more large grants.

In considering the effect of the diversion of water from the upper river on the American and Horse Shoe Falls, it should be remembered that the channel leading to the former, owing to its greater elevation and less width, carries only 10 to 20 per cent. of the total river discharge. As a result, a reduction of a very few feet in the river level above Goat Island will lay bare the channel to the American Falls, while the Horse Shoe Falls still carry a large volume of water. If diversion of water above the falls was the only practicable method of developing Niagara power, it might be very hard for New York to check the ardor of investors, or for the Government of Ontario to deny itself further income from the lease of water rights. While it is entirely practicable, however, to develop some 1,500,000 electric horse power in the gorge, there seems to be lacking any good excuse for the complete destruction of the American Falls. Nor is this conclusion shaken by the probability that the development of power sites in the gorge will be somewhat more expensive per unit than that of plants close to the falls. Those who have enjoyed the wild scenery of the White Horse Rapids at close range will be loth to give them up, but when the hard alternative is to drown these rapids or dry up the American Falls, the former seems much the less of the two evils.

THE EFFECTS OF VACUUM ON STEAM-ENGINE ECONOMY.

By R. M. Neilson.

Mr. Neilson's first two articles in the current series dealt with the use of superheated steam. His third, in our issue for May, discussed the general aspects of the economy of condensing. The present paper reviews the principal types of condensing apparatus and their operation. A concluding section will take up cooling towers and give further attention to air and circulating pumps and other auxiliaries.—THE EDITORS.

A NON-CONDENSING engine is often converted into a condensing one, not for the sake of economy, but in order to obtain a greater power without the installation of a fresh engine and a fresh boiler. Greater efficiency should be obtained in every case, but whether there will be any commercial gain depends upon the circumstances of the case.

The financial advantage to be obtained by condensing depends, of course, on the nature and cost of the water obtainable, which involves the question of the most suitable type of condensing plant. If the water obtainable for condensing purposes is suitable for use as boiler feed water, and if the price of this water does not prohibit its being used in considerable quantities, it is usually advisable to employ a jet condenser. It may also be advisable to use a jet condenser in the very opposite case—namely, when the water is extremely bad and would cause a deposit on the tubes of a surface condenser such as would much impair the efficiency of the condenser unless this were very frequently cleaned. In such a case it is usually best to employ a jet condenser (or an ejector condenser) and use fresh water for the boiler feed instead of drawing this from the hot well. A limited supply of pure water suitable for boiler feed is usually obtainable, although it may be too expensive to use for condensing purposes with a jet, ejector, or surface condenser. Compared with surface condensers, jet condensers are cheap and simple and do not readily get out of order; and if the counter-current system (to be described hereafter) is adopted, they are very effective in obtaining a high vacuum.

It is of course desirable with any condenser to have the condensing water as cold as possible, as then a given weight of it has a greater cooling effect: and it is easier to get the heat of the steam

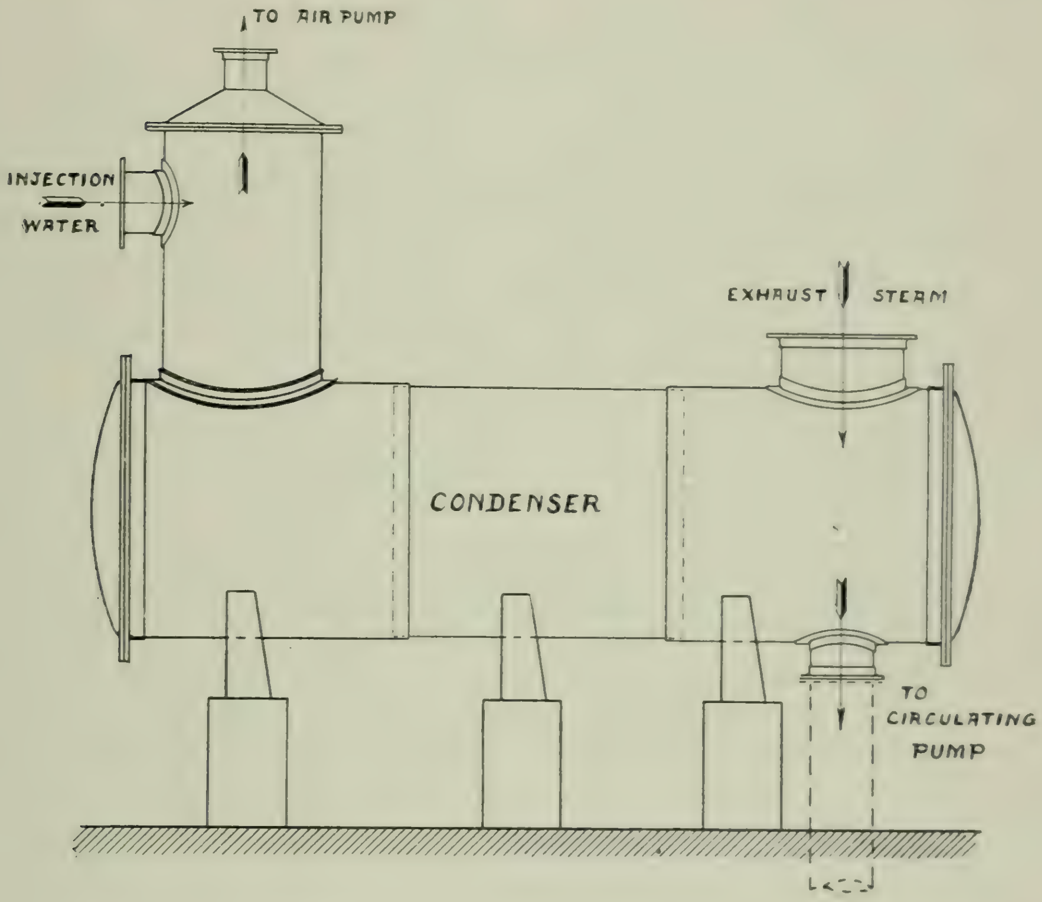
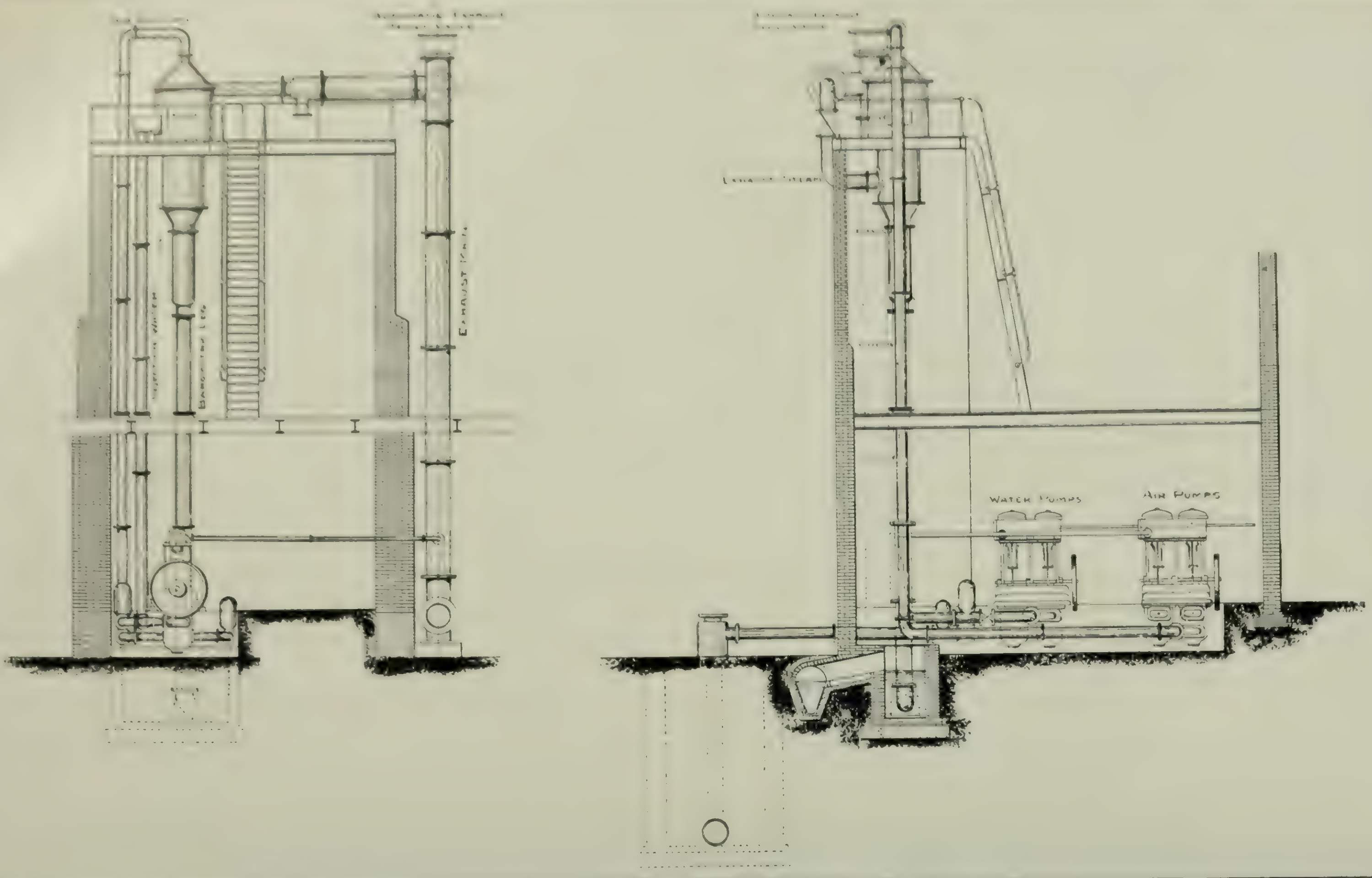


FIG. I. HORIZONTAL COUNTER-CURRENT JET CONDENSER.
Klein Engineering Co., Ltd., Manchester.

(and air) transferred to the cooling water when there is a considerable difference of temperature between these than when there is only a slight difference. If very cold condensing water cannot be obtained, and if condensing water has to be used which is at a temperature very near to the required temperature of the steam and condensed water in the condenser to give the desired amount of vacuum, a jet condenser of the counter-current type is much to be preferred to a surface condenser of any type. In a jet condenser the cooling water mixes with the steam and air and can directly acquire heat from them, whereas in a surface condenser the heat has to be transferred through metal.

A standard design of horizontal counter-current jet condenser as made by the Klein Engineering Company, Ltd., of Manchester, is shown in Figure 1. The exhaust steam enters at one end of the condenser and the air contained in the steam is drawn the full length of the condenser and makes its exit along with the (cold) air which enters with the injection water, just above the place where the water



FIGS. 2 AND 3. VERTICAL COUNTER-CURRENT JET CONDENSING PLANT FOR AN ELECTRIC GENERATING STATION.

Klein Engineering Co., Ltd., Manchester.

enters. The injection water along with the condensed steam leaves the condenser just below the place where the steam enters.

This counter-current arrangement allows of the air leaving at the lowest possible temperature and therefore with the lowest possible volume. This is an important consideration as regards the necessary capacity of the air pump. The counter-current arrangement also gives the water the opportunity of acquiring as much heat as possible. It is desirable that this should be so in order to provide feed water at as high a temperature as possible, and in order that as small a quantity of injection water as possible may be used. The reduction in the amount of injection water used is important even if the water is obtained for nothing, as it not only reduces the necessary capacity of the water pump or pumps, but it also reduces the necessary capacity of the air pump, because the more injection water used, the more air will come in with it and have to be removed by the air pump. In a condenser of this nature it is usual, as the air and water leave the condenser separately, to employ separate pumps for withdrawing them—namely, a dry air pump (which is almost invariably of the reciprocating type) and a water pump, which is usually reciprocating but not infrequently rotary.

Figures 2 and 3 illustrate a counter-current vertical barometric jet condenser and pumps supplied by the Klein Engineering Company, Ltd., to a corporation electricity works. The plant is of a capacity of about 1,500 horse power and deals with the exhaust steam from high-speed reciprocating engines. River water is employed for condensing, and a vacuum of 27 to 28 inches of mercury is obtained. Twin air pumps are employed which are driven by a compound steam engine. The injection water is supplied by a similarly driven pair of water pumps. It will be seen that the injection water enters the condenser near the top and that the air is withdrawn at the very top, where it will be coolest and densest. The exhaust steam, as seen in Figure 3, enters well below the injection water.

The condenser is situated at a height above the ground nearly as great as if not greater than the height of a water barometer (hence the term "barometric condenser") so that the condensing water and the water of condensation will discharge themselves by gravity in spite of the vacuum in the condenser.

A condenser of the barometric type has the advantage that no pump is required to draw off the water. When a high vacuum is desired at the engine the barometric condenser has the objection of the long exhaust-steam pipe.

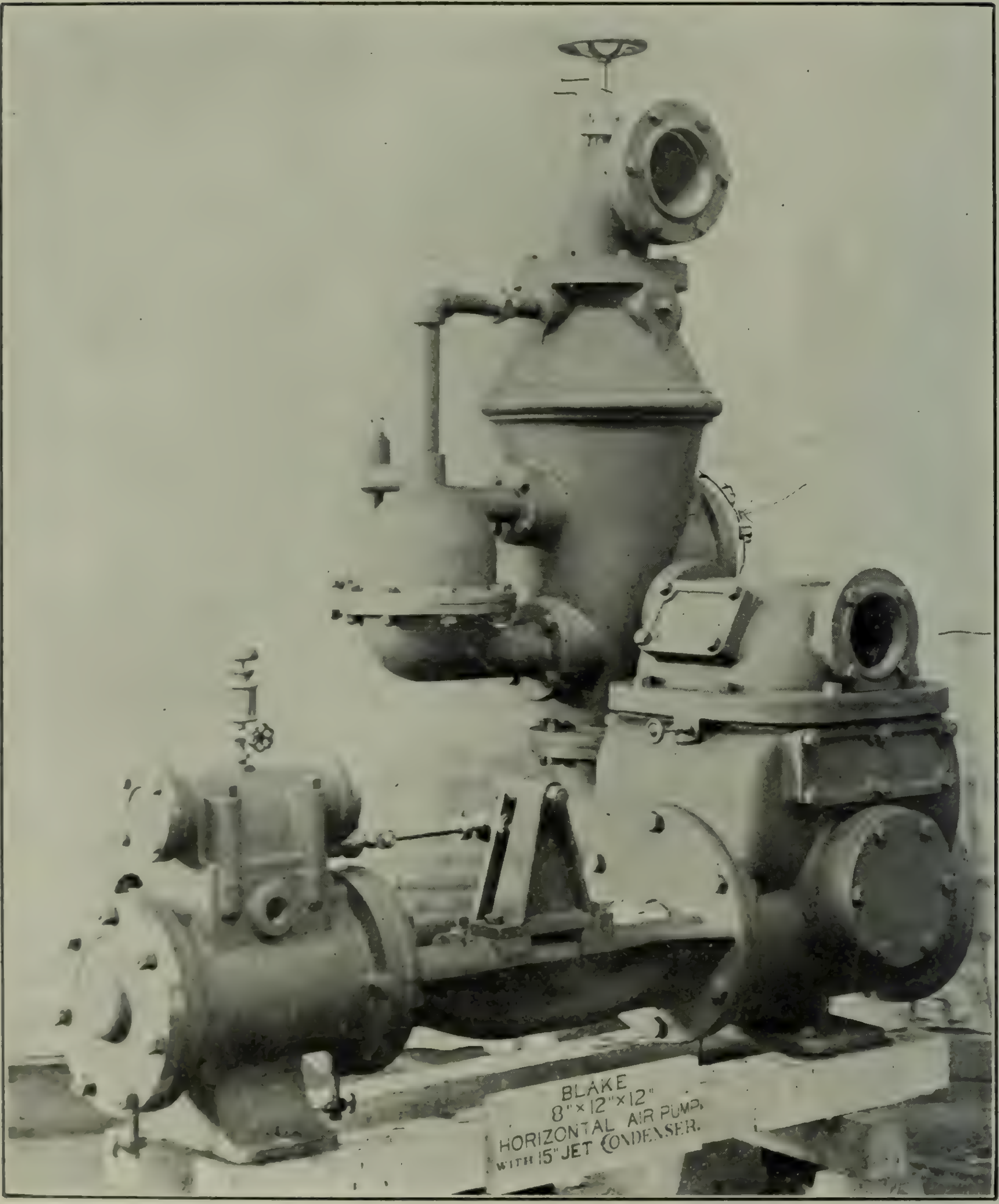


FIG. 4. BLAKE JET CONDENSER AND AIR PUMP.

Made in sizes capable of dealing with from 1,600 to 26,000 lb. of steam per hour, with condensing water not over 70° F. Built by International Steam Pump Co., New York.

Although the counter-current arrangement of jet condenser is very advantageous, parallel-current jet condensers are very commonly employed, the exhaust steam and the injection water entering at one end, usually the top, and the water and air being withdrawn together at the other end by the same pump or pumps. An example of such a construction is shown in Figure 17, the triple-throw pump being seen behind the condenser.

If the water is unsuitable for use in boilers in the state in which it is obtained, we cannot draw our feed water from the hot well and at the same time use condensers in which the condensing water is mixed with the condensed steam. The condensers in such cases must be of the surface type, and to make up the losses in the boiler feed we must supplement the water obtained from the hot well by purifying some of the supply (impure) water or purchasing some relatively expensive pure water.

Figure 7 shows a 6,000-indicated-horse-power surface condenser constructed for the Manchester Corporation Electricity works by Messrs. Mather and Platt, Ltd., of Manchester. The body and end covers are of cast iron. The tubes are of brass, and the tube plates

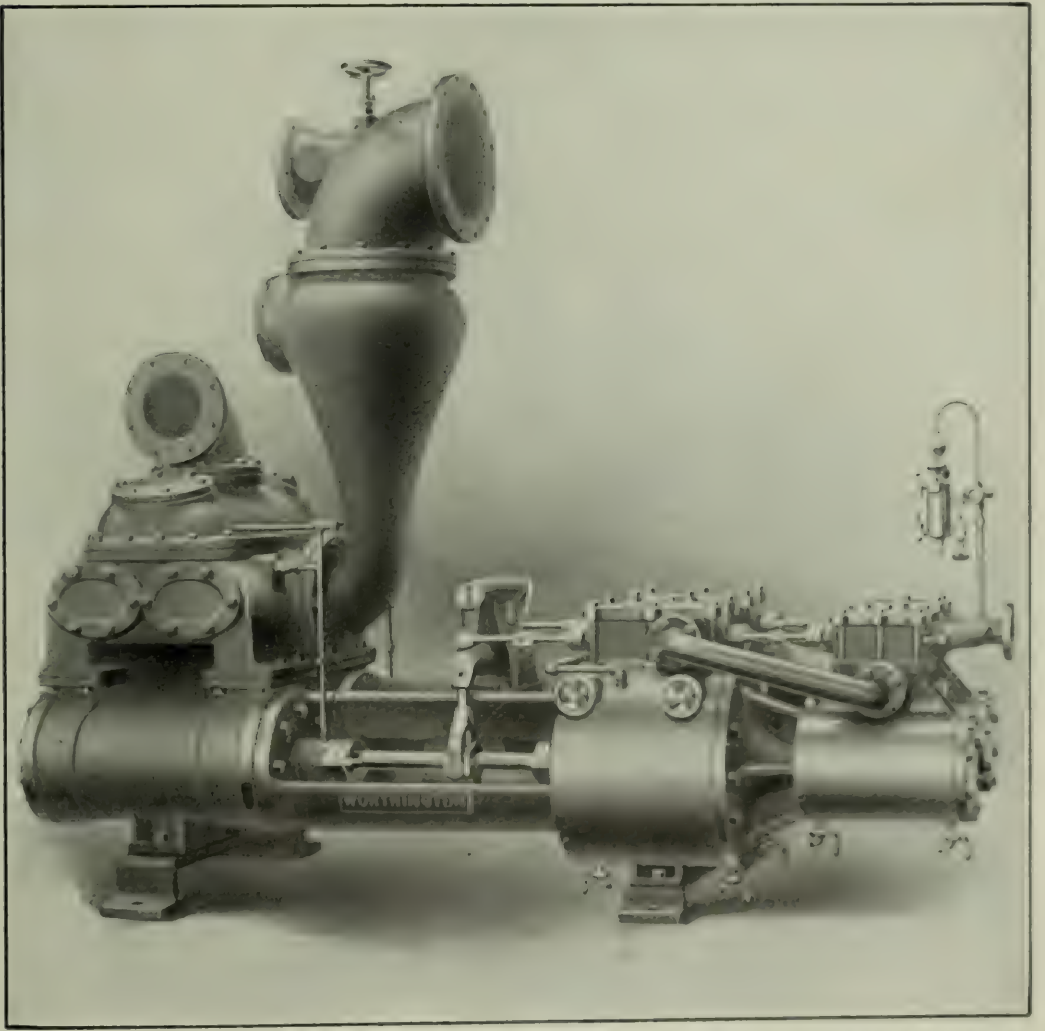


FIG. 5. WORTHINGTON AIR PUMP AND JET CONDENSER WITH COMPOUND STEAM CYLINDERS.

Suitable especially for large plants where the feed water is heated by economizers or exhaust steam. The cost of producing vacuum is minimized. Built in sizes from 1,000 to 10,000 horse power. International Steam Pump Co., New York.

are also of brass, the tubes being secured to the tube plates by brass ferrules. The circulating water, as is usual, passes through the tubes, the exhaust steam being on the outside of the tubes.

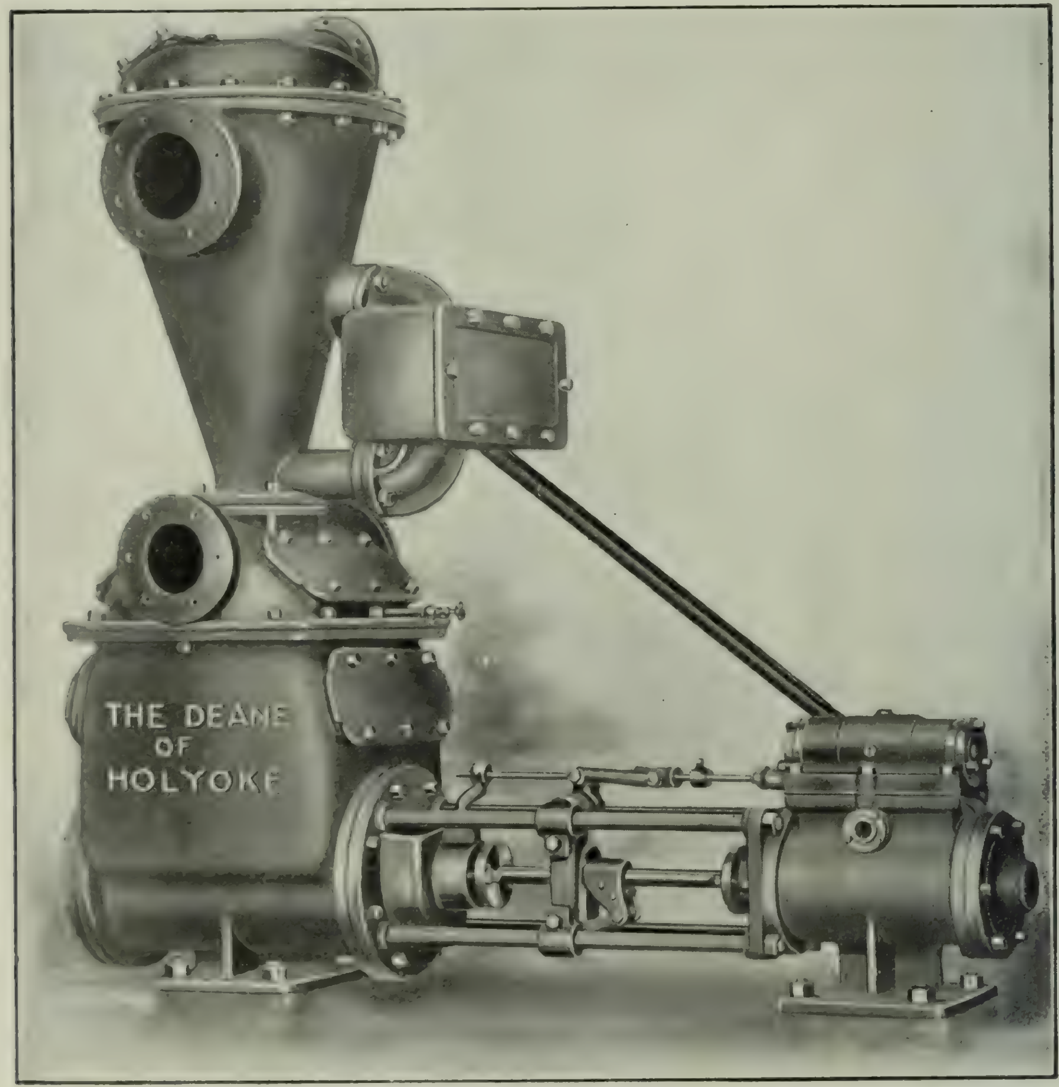


FIG. 6. DEANE JET CONDENSER, WITH SINGLE DIRECT-ACTING HORIZONTAL VACUUM PUMP.

International Steam Pump Co., New York.

Figure 8 shows a surface condenser with air and circulating pumps constructed by the Mirrlees Watson Company, Ltd., of Glasgow, and installed at the Northampton Electricity Station. The plant is designed to deal with 12,000 pounds of exhaust steam per hour and to give a 26-inch vacuum. The twin air pump seen in the front is of the Edwards type and is driven through single reduction gearing by the electric motor on the right. The two adjacent crankshaft-supporting brackets of this pump are bolted together at the top and carry a common pair of long brasses and a common long

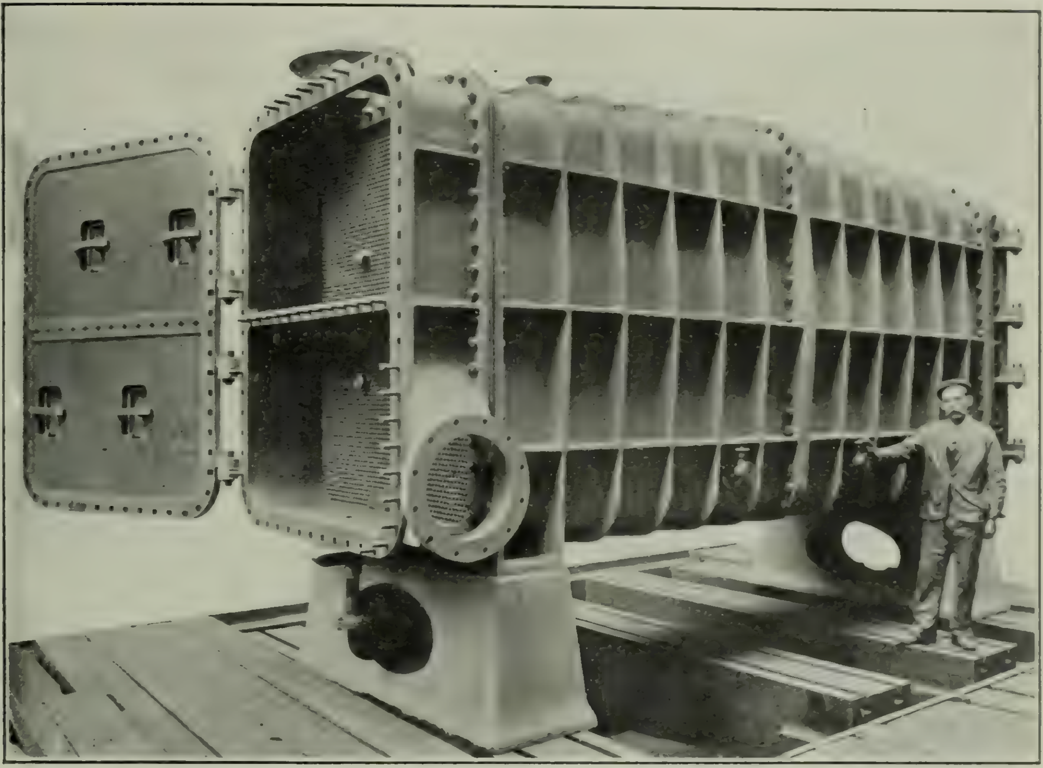


FIG. 7. A 6,000-HORSE-POWER SURFACE CONDENSER FOR THE MANCHESTER CORPORATION ELECTRICITY WORKS.

Mather & Platt, Ltd., Manchester.

cap. The centrifugal pump seen direct-coupled to the electric motor on the left is for circulating the cooling water through the condenser tubes. The surface condenser is seen at the back. It is of cast iron with brass tubes and tube plates and ferrules.

Figure 9 illustrates a surface-condensing plant constructed by the Mirrlees Watson Company, Ltd., to work in connection with

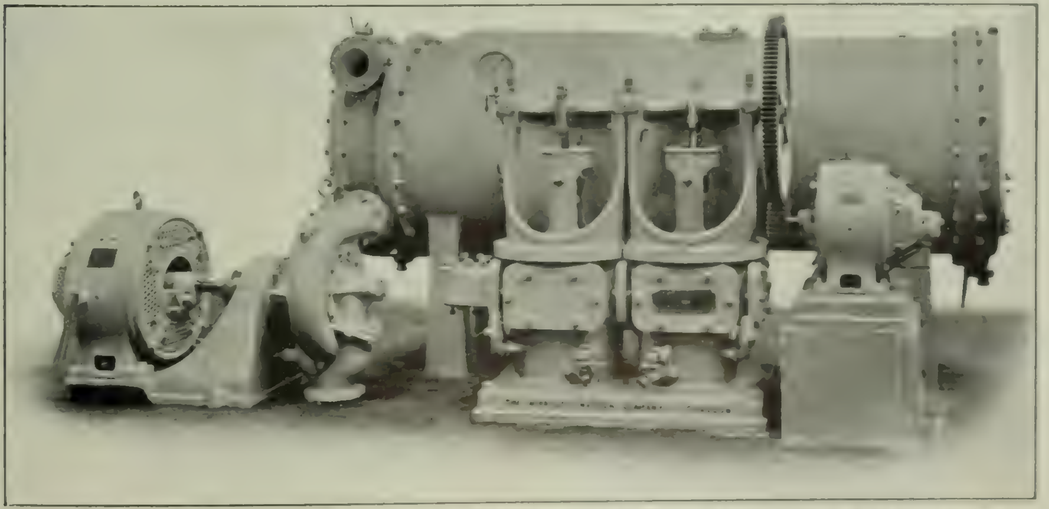
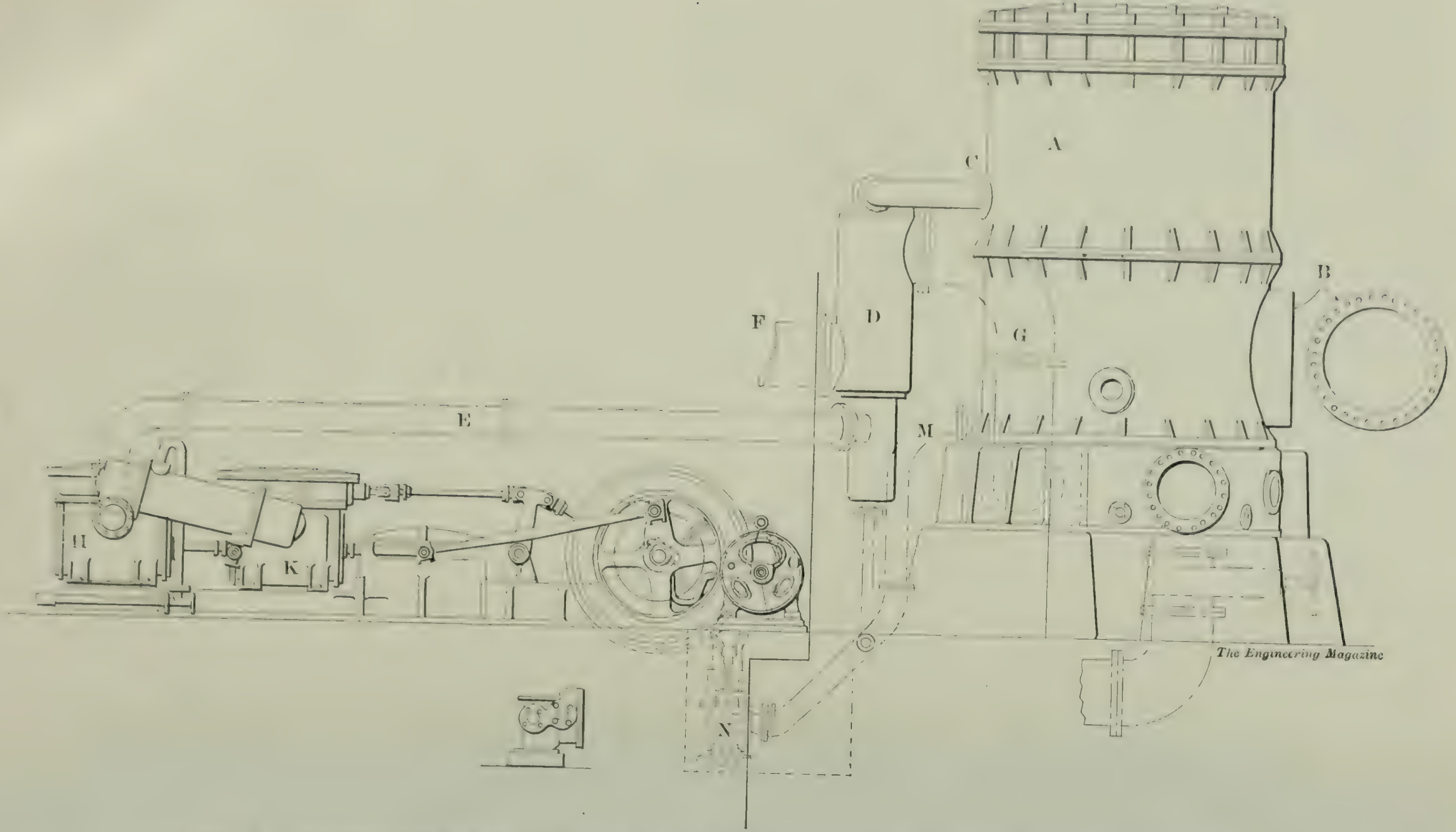


FIG. 8. SURFACE CONDENSER WITH MOTOR-DRIVEN AIR AND CIRCULATING PUMPS.



The Engineering Magazine

FIG. 9. SURFACE CONDENSING PLANT FOR USE IN CONNECTION WITH WESTINGHOUSE TURBINES.

the Westinghouse turbines for India. There are two surface condensers, each arranged with its own pumps and each designed to deal with 26,250 pounds of exhaust steam per hour at normal load and to maintain a vacuum of 27½ inches of mercury (with the barometer at 30) when using cooling water at 87 degrees F. Each set is also expected to be able to deal with 40,000 pounds of steam at overload and with this quantity of steam to maintain a vacuum of at least 26 inches. Only one set is here shown.

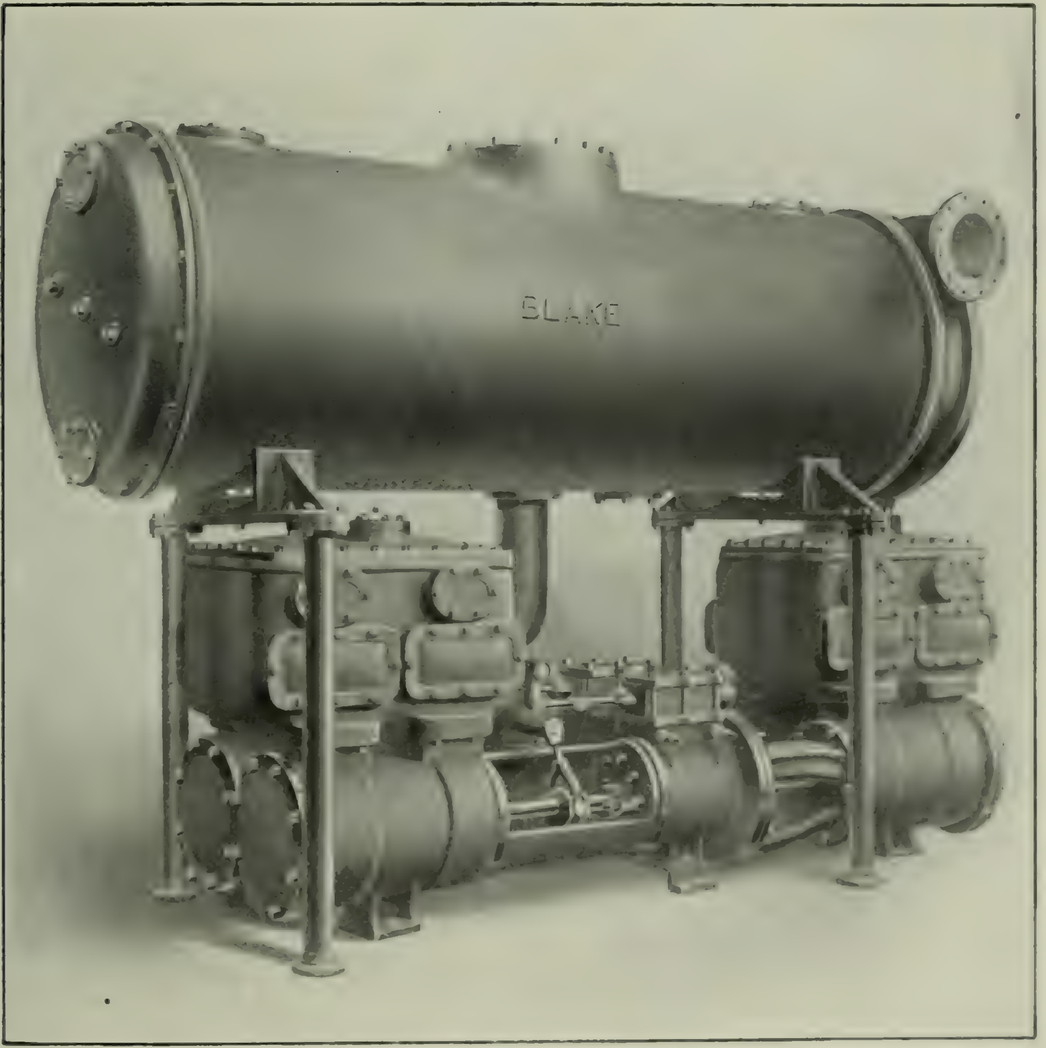


FIG. 10. SURFACE CONDENSER WITH AIR AND CIRCULATING PUMP.
Cast-iron shell, with baffle plate to distribute exhaust steam seamless drawn brass tubes, with ends passing through adjustable glands permitting free expansion and contraction. International Steam Pump Co., N. Y.

A is the surface condenser, which is of the vertical type and is constructed of cast iron. The exhaust steam enters the condenser through port B, which is 36 inches in diameter, and passes four times the full length of the condenser. The air is withdrawn from the

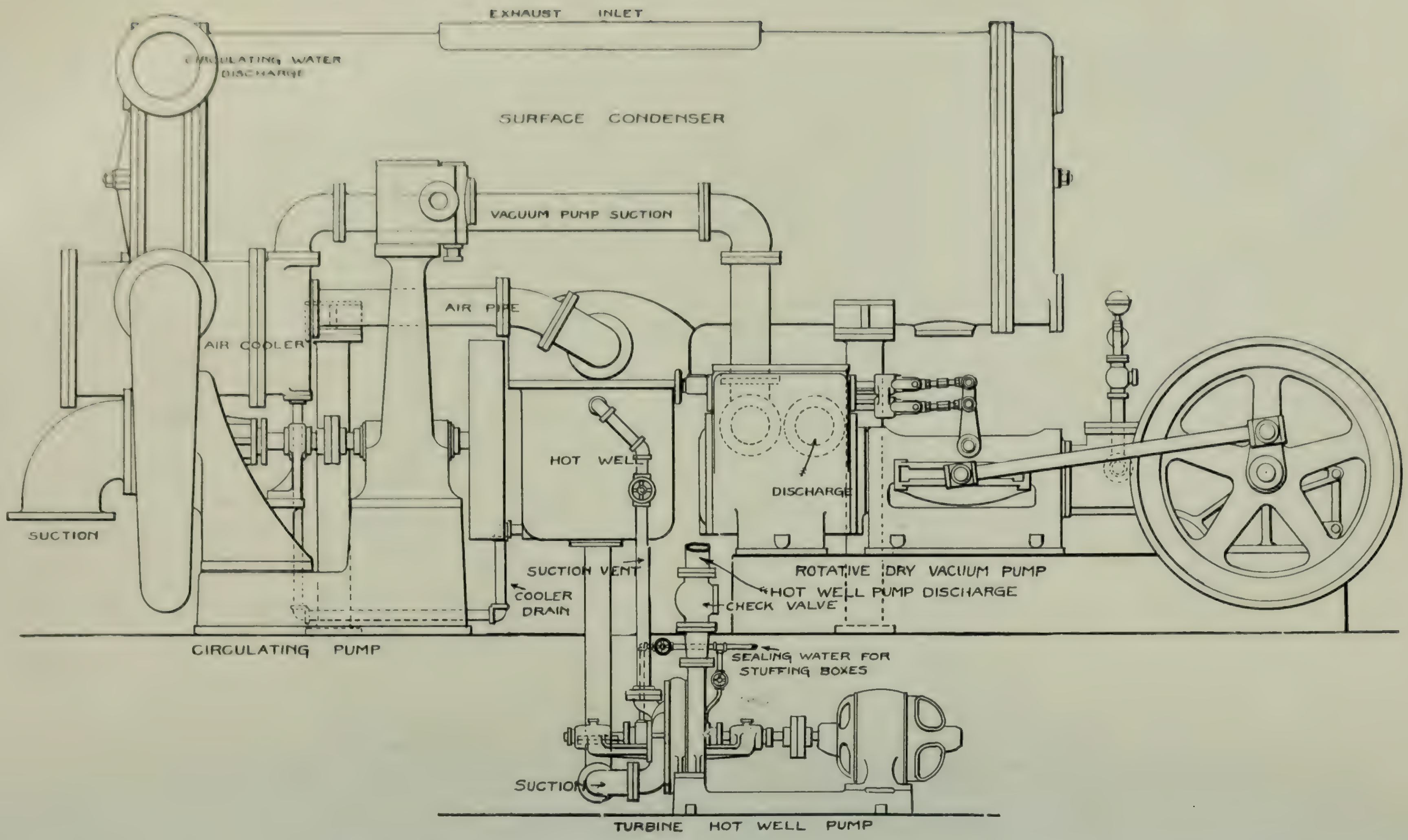


FIG. 11. WORTHINGTON CONDENSING APPARATUS FOR STEAM TURBINES. International Steam Pump Co., New York.

condenser at C and is sucked through tubes in the vessel D, leaving this vessel and passing to the dry air pump by the pipe E. The circulating cooling water approaches the condenser by the way of the pipe F. It passes through the vessel D around the air tubes and then proceeds by way of the pipe G to the condenser, which it enters at the bottom. Division plates are arranged in the condenser so as to cause the water to pass four times the full length of the condenser in the opposite direction to the steam, thus producing a counter-current arrangement. The condenser has 5,880 square feet of cooling surface. The tubes are of solid drawn brass 1-inch external diameter and 18 S. W. G. thick.

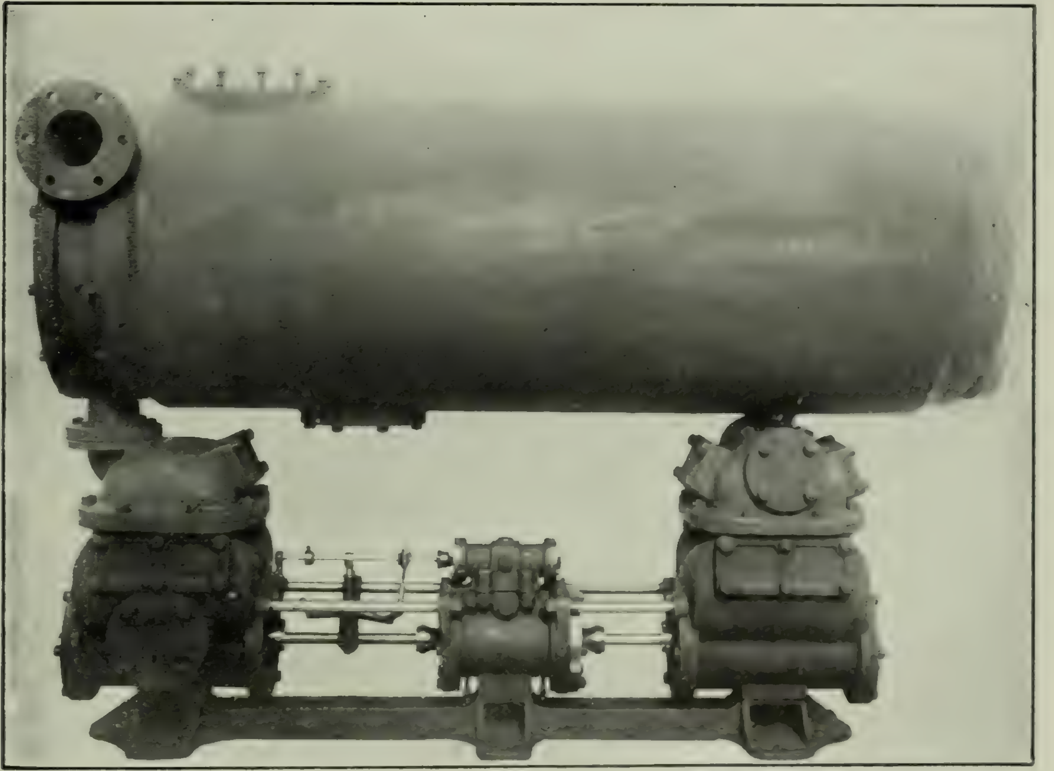


FIG. 12. KNOWLES COMBINED AIR AND CIRCULATING PUMP WITH SURFACE CONDENSER OF 400-SQUARE-FEET SURFACE.
International Steam Pump Co., New York.

A two-stage horizontal air pump is employed. The two cylinders H and K are arranged tandem on the same bed plate. They are each 17 inches in diameter and have each a stroke of 24 inches. The air pump deals only with air and vapor, the water of condensation being drawn off from the condenser along the pipe M, (where it is joined by the water separated from the air in the vessel D) by the small double-acting plunger pump N which is $6\frac{3}{4}$ inches in diameter and 12 inches in stroke and is driven at 40 revolutions per minute through

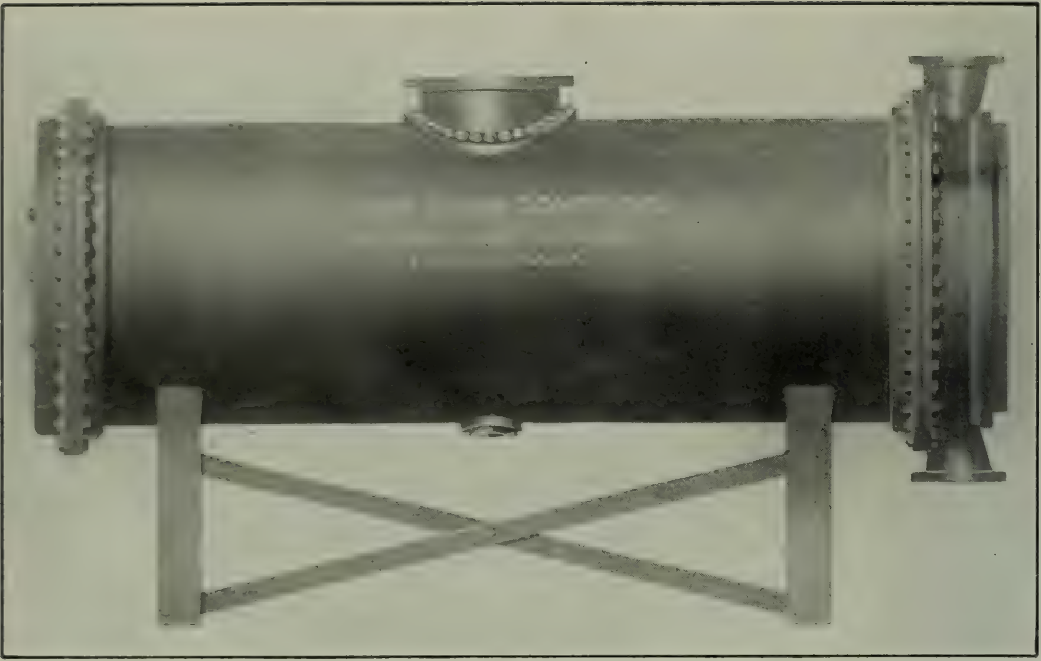


FIG. 13. THE LOEW SURFACE CONDENSER.
Loew Supply & Manufacturing Co., Cleveland, O.

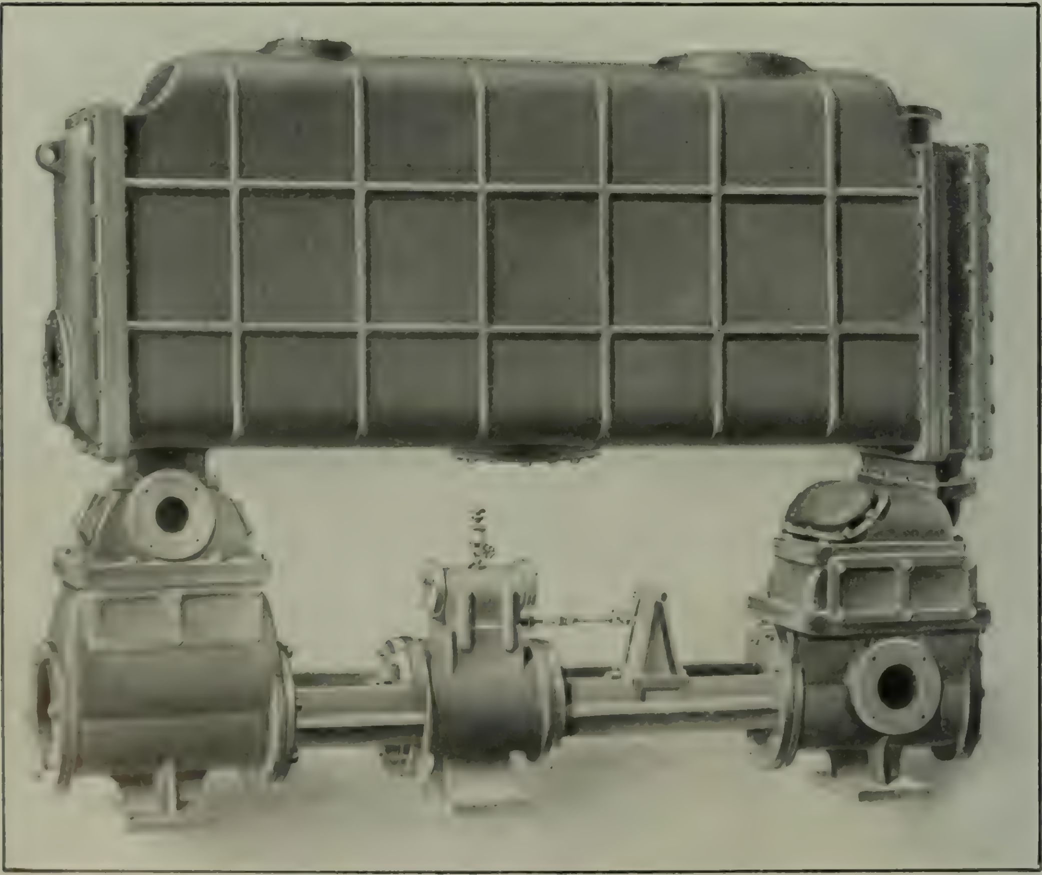


FIG. 14. BLAKE-KNOWLES RECTANGULAR SURFACE CONDENSER, MOUNTED OVER COMBINED AIR AND CIRCULATING PUMPS, ADMIRALTY STYLE.
International Steam Pump Co., New York.

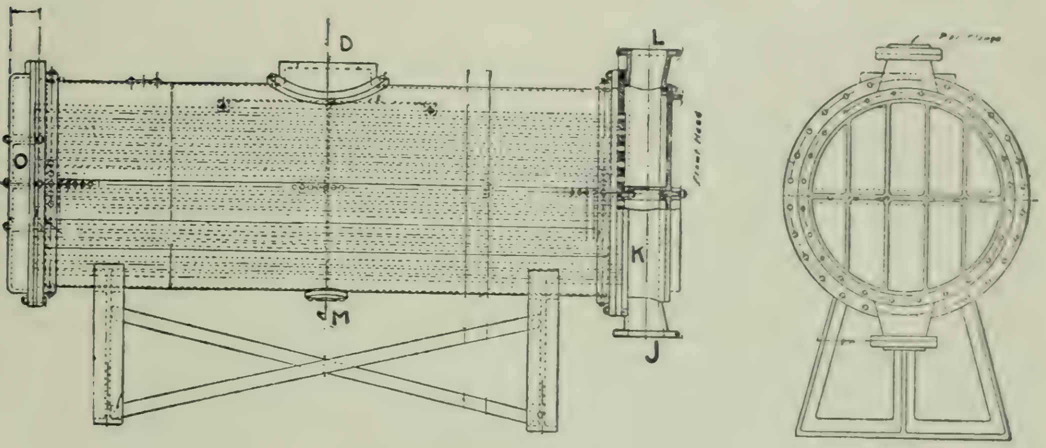


FIG. 15. SECTIONAL DIAGRAM OF LOEW CONDENSER.
The steam inlet is at D, the condensed water being drawn off at M. The circulating water is introduced at J, passes through the multitude of small tubes to the bonnet O, returns through the upper tubes, and makes its exit at L.

gearing from the air-pump crank shaft, which is itself driven at 100 revolutions per minute through single-reduction gearing by the electromotor O. The inlet of air to the cylinders of the air pump is controlled by a D slide valve arranged in a trick port to equalize the pressure at the ends of the cylinders at the end of the stroke. The discharge valves are automatic and controlled by springs. It is expected that 110 pounds of water will have to be circulated through the condenser for every pound of steam condensed. Centrifugal circulating pumps are employed which are placed at some distance from the condensers and are not shown in the drawings.

A form of surface condenser which is of comparatively recent date and which is very small and light for its capacity is the Ljungström condenser. This condenser consists of a number of rectangular plates which are corrugated diagonally and arranged with suitable spacing frames within a casing. Figure 16 shows some of the plates and spacing frames. It will be seen that every frame has two opposite sides

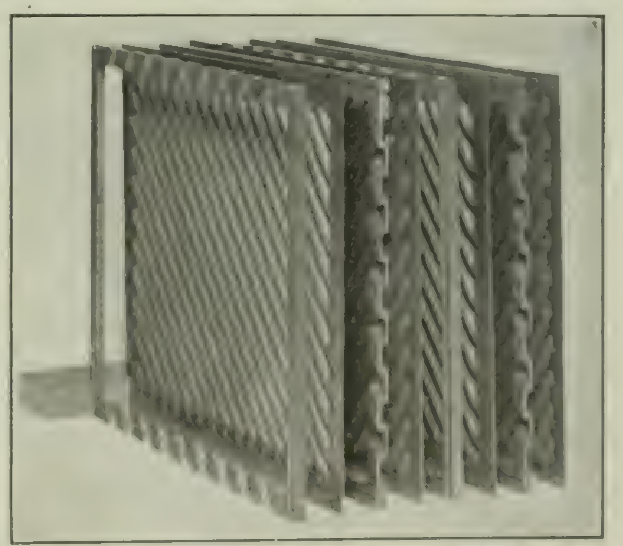


FIG. 16. PLATES AND SPACING FRAMES OF LJUNGSTRÖM SURFACE CONDENSER.

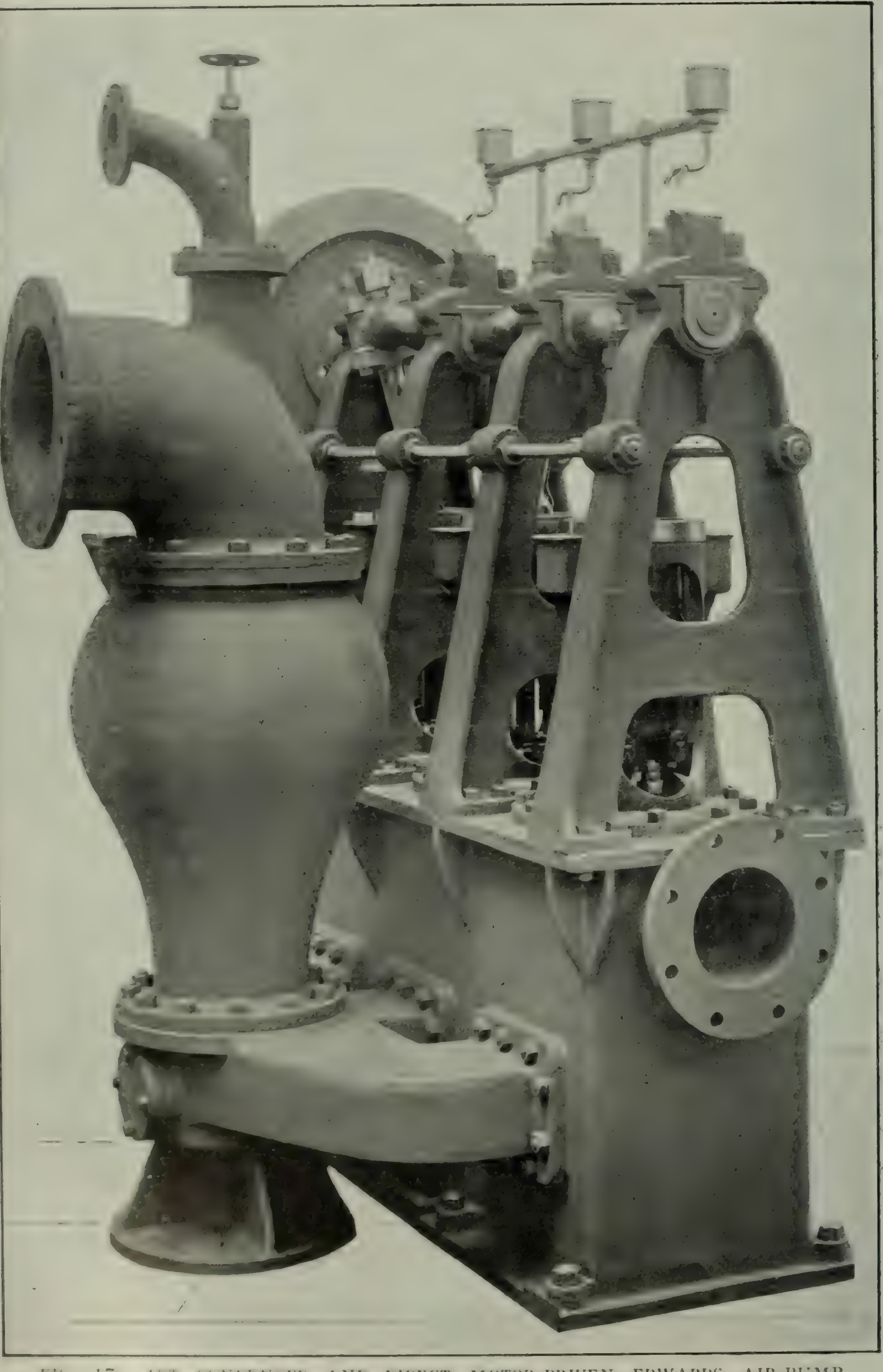
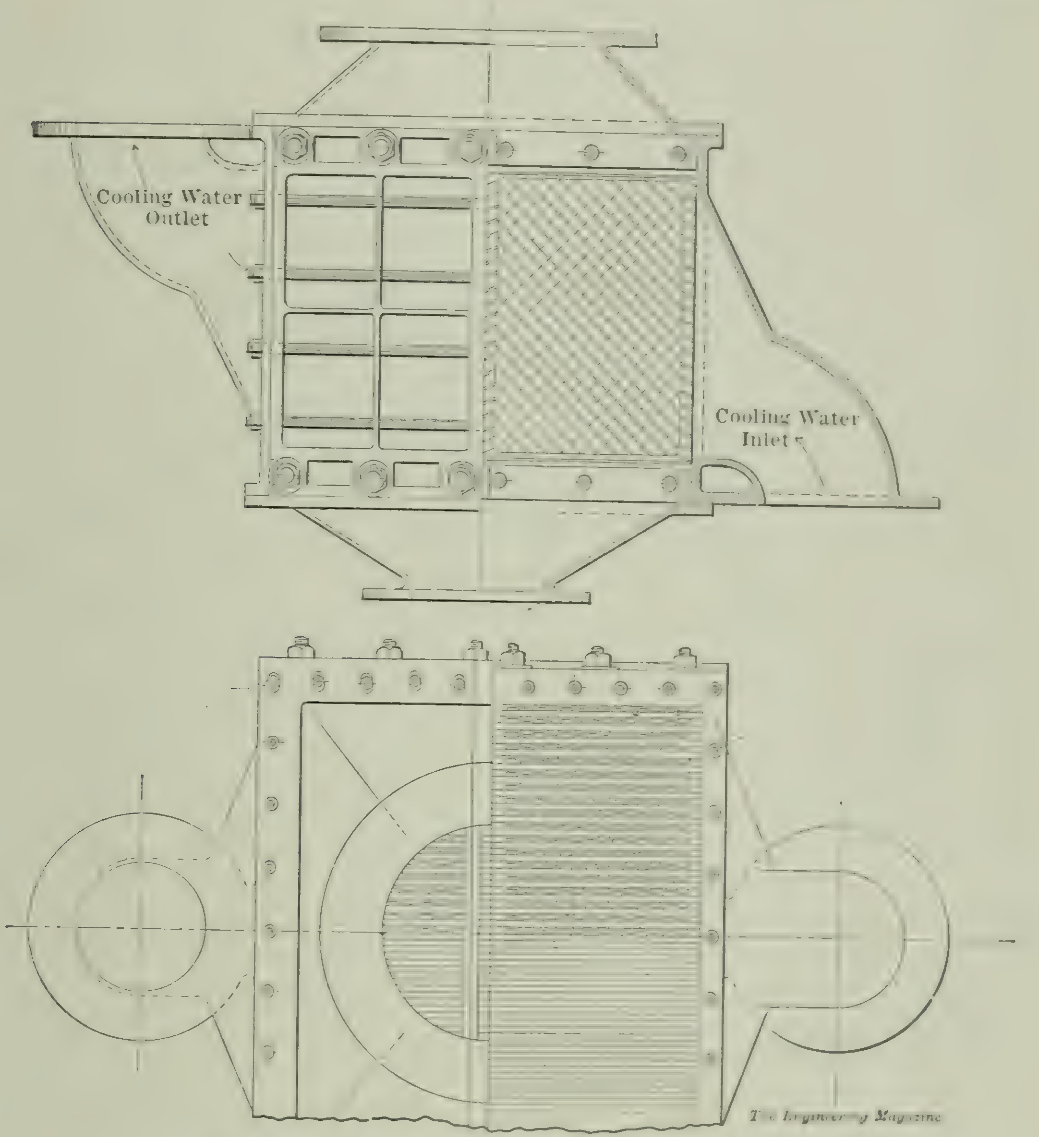


FIG. 17. JET CONDENSER AND DIRECT MOTOR-DRIVEN EDWARDS AIR-PUMP.

To deal with 8,000 lb. of steam per hour and maintain a vacuum of 27 in. with injection water at 65° and the barometer at 30 in. The Edwards Air-Pump Syndicate, London.



FIGS. 18 AND 19. LJUNGSTRÖM CONDENSER PLANT.
The upper figure shows an elevation, partly in section; the lower, a plan, with half the cover removed.

solid and the other two sides shaped in zig-zag fashion, and the alternate frames have different pairs of sides so arranged. Consequently when the plates and frames are clamped together, some of the chambers between the corrugated plates are open at the top and bottom and the other chambers are open at the sides. The steam to be condensed is passed through the one set of chambers and the condensing water is passed through the other set. The corrugations on the plates run alternately in different directions at right angles to each other and the corrugations of any plate touch those on the plates on both sides of it. The steam and water in their passage through the condenser are therefore very much broken up. The plates are made up in a set or "bunches" and a condenser may consist of one or more bunches. Figure 22 shows a Ljungström condenser composed of two bunches, each with 73 plates. Figure 18 is an elevation, partly in section, of this condenser and Figure 19 is a plan with half of the top cover removed. The casing is made of phosphor-bronze. The exhaust steam enters at the top (in Figure 18) and passes downwards through every alternate chamber between the plates. The bottom flange is for connection to the pipe leading to the air pump. The circulating water enters at the right (Figures 18 and 19) and leaves at the left after passing through the intervening chambers between the plates. This condenser was recently supplied by Messrs. Dunford & Elliott, of Newcastle-on-Tyne, to the Russian Admiralty, to be installed on board one of the vessels of the Baltic fleet. The weight of the condenser empty is about 4¾ hundredweights and it is designed to deal with 5,000 to 6,000 pounds of exhaust steam per hour.

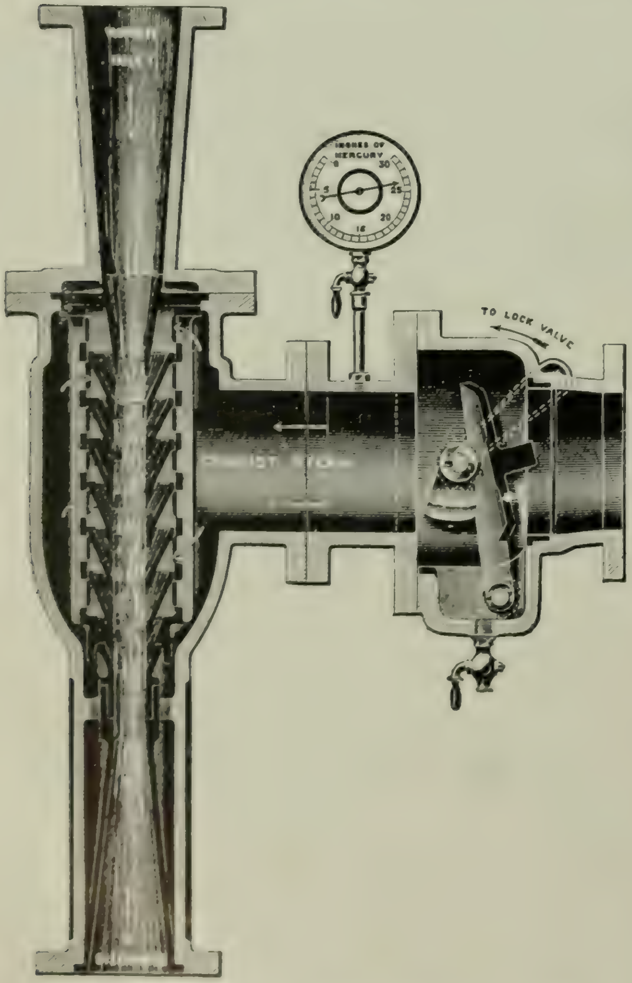


FIG. 20. LEDWARD'S EJECTOR CONDENSER.

The yacht Snowdrop II has quadruple-expansion engines designed to indicate 420 indicated horse power at 900 revolutions per minute. A Ljungström condenser has been fitted on board this yacht by Messrs. Simpson, Strickland & Co. to deal with the exhaust steam from these engines. This condenser has a cooling surface of 130 square feet and weighs 4.05 hundredweights empty and 4.94 hundredweights when filled with water. The outside dimensions of the casing are 38 inches by 18 inches by 13 inches. This condenser has, it is said, been able to

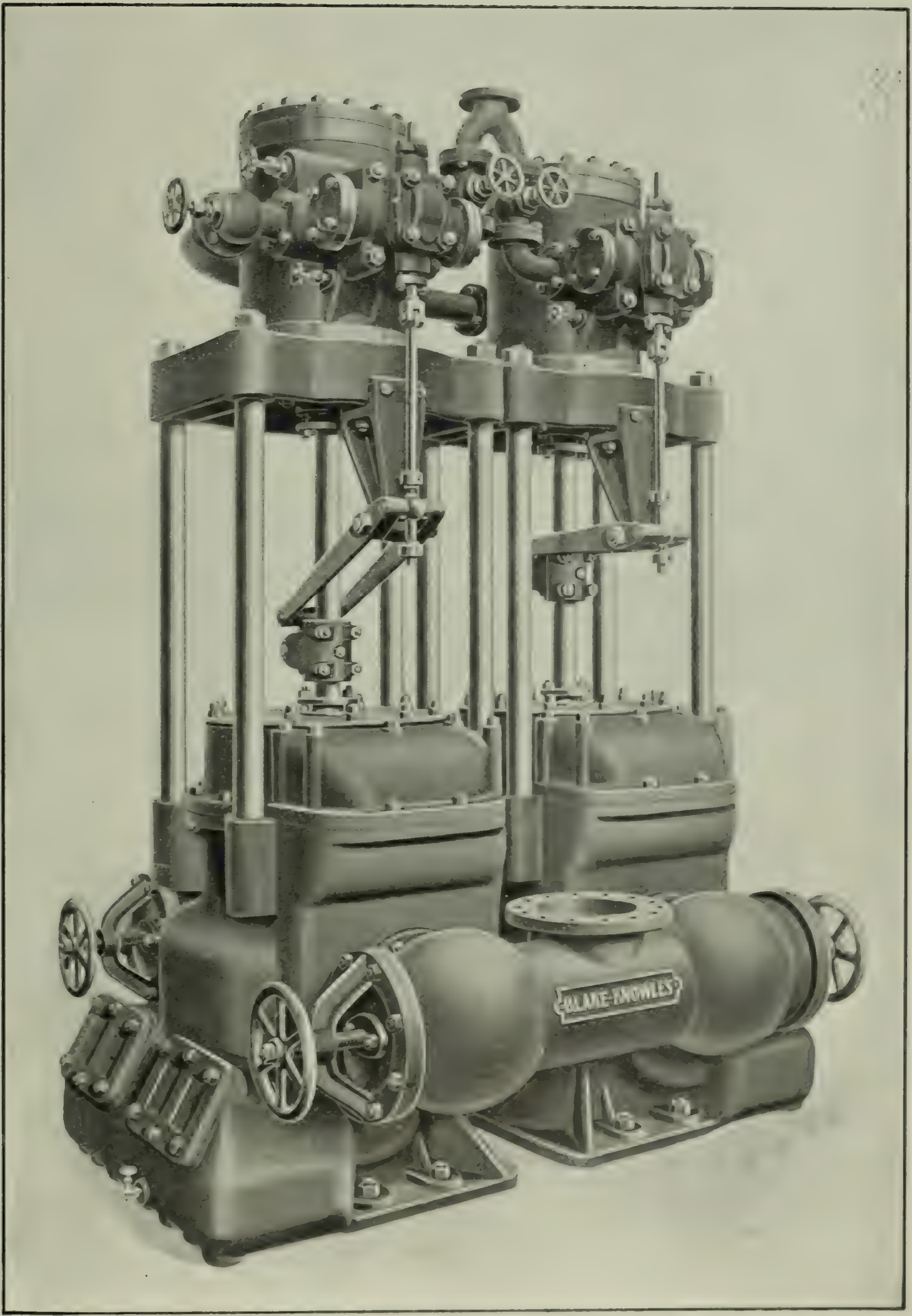


FIG. 21. BLAKE TWIN AIR PUMP FOR 8,000-HORSE-POWER ENGINES.
Double-acting "suction valveless" pattern. Either side can be run separately if desired.
International Steam Pump Co., New York.

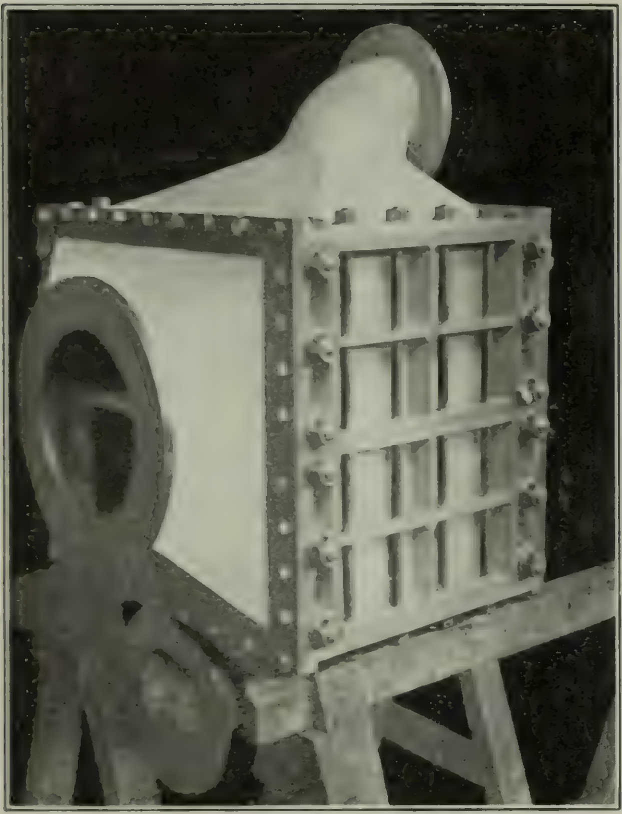


FIG. 22. LJUNGSTRÖM SURFACE CONDENSER FOR A RUSSIAN WARSHIP.

maintain a vacuum of 22½ to 23½ inches of mercury at full load, and a very much higher vacuum under cruising conditions.

A convenient type of condenser to use in many cases is the ejector condenser. An ejector condenser is simple and cheap and takes up little room. No air pump is required with it, and if a sufficient head of condensing water is obtained no pump is required for this either. There is then no moving part at all. Ejector condensers require about 25 or 30 pounds of water per pound of steam condensed. It is very important that the condensing water should be cool. An ejector condenser as made by Messrs. Ledward and Beckett, Ltd., of London, is shown in Figure 21. The condensing water, preferably under a head of 15 or 20 feet, enters at the top and the steam enters at the side. A number of conical passages are arranged in which the steam meets the water and is condensed, the combined fluids being discharged at the bottom. A check valve is shown at the right of the figure. This closes automatically if the condenser should suddenly cease to work through failure of the water supply. A back rush of water to the engine is thus prevented. The valve can be locked closed by a cam and lever when the engine is working non-condensing.

THE QUESTION OF THE GAS TURBINE.

By Prof. Sidney A. Reeve.

Professor Reeve's research, experiment, and practical work in the development of the gas turbine have been more than once noted in these pages, and are too well-known to need further citation. The present article will be recognized as a very valuable contribution to the knowledge of the subject. So far as concerns the dry-gas turbine, it is in direct reply to Dr. Lucke's paper which appeared in our issue for April last. Dr. Lucke, it will be recalled, expressly excepted from his discussion all reference to the problem of the turbine in which the products of controlled combustion were mixed with steam.—The Editors.

THE promise held forth by the much talked of but as yet invisible gas-turbine cannot be rightly estimated without a correct knowledge of the true position occupied by its forebear, the steam-turbine. It is worth while to review briefly the reasons for the latter's existence.

It is well-known that the prime problem of steam-engine design, from the days when James Watt first established the fact until now, has been that of cylinder-condensation. This phenomenon is due wholly to temperature-fluctuation within the cylinder. Consequently the steam-turbine, maintaining, as it does, a sensibly constant temperature at each point in the course of the steam at all times, constitutes the only natural and complete solution to the problem. In steam-turbines the detrimental phenomenon, instead of consisting of a decrease of entropy from loss of heat in condensation, consists in an increase of entropy from fluid-friction.

In addition to this point the comparison between piston-engine and turbine rests upon the purely mechanical feature of the high rotative speed of the latter, with its consequent reduction of dimensions and freedom from vibration. For the present it is sufficient to state that this feature now appears in the light of a disadvantage and a problem, almost as much as it does as an advantage, taking all services together. At any rate, we are here chiefly concerned with the thermodynamics rather than with the mechanics of the question.

The rapid evolution and the marked success of the steam-turbine, occurring at practically the same time as the development of the internal-combustion engine, have frequently led to the natural question: "Why not a gas-turbine?" Before attempting to see if this

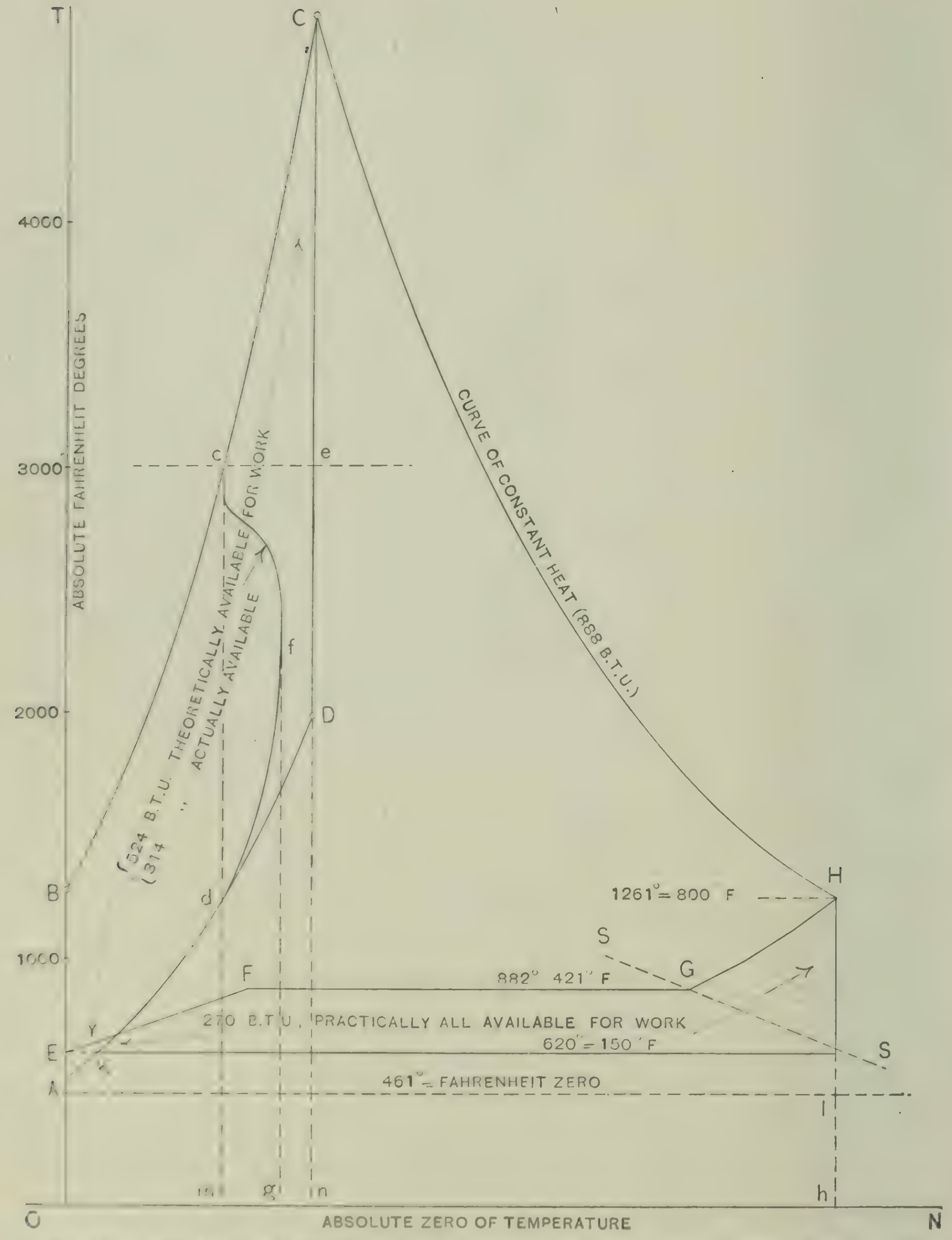


FIG. 1. DIAGRAM OF ACTION OF ONE POUND OF PERMANENT GASES AND 0.636 POUND OF WATER.

314 B. t. u. utilized (cycle ABcfd) is the equivalent of about 11 cu. ft. of city gas per horse-power hour. This is what a piston-engine working on the Joule cycle to 300-lb. pressure might expect to do. 270 B. t. u. utilized (cycle AEFG-HIKA) is the equivalent of about 13 cu. ft. of city gas per horse-power hour, which is what the water-cooled gas-turbine might be expected to do. Both cases neglect friction-losses of the mechanical sort.

suggestion be possible of adoption in practice, it is necessary to inquire: "Is it desirable?" Is the situation between gas-turbine and gas-engine the parallel of that between steam-turbine and steam-engine?

In the explosive type of gas-engine, the cylinder-wall action, which is the exact physical parallel of the cylinder-wall or condensive action in the steam-engine, plays a very different role from it in the thermodynamic efficiency of the engine. In steam-engines the temperature-range is lower than is desirable. Therefore it is necessary to conserve temperatures at all costs. "Keep the cylinder as hot as the entering steam," said James Watt, one hundred and forty years ago; and ever since then we have been trying to do it. But in the gas-engine the situation is quite reversed. Our greatest problem is that involved in the excessive temperature. We are forced to keep it down at any cost, even at the cost of valuable heat. Therefore we enclose the cylinder in a water-jacket, and into this jacket is thrown all heat developed above a certain permissible maximum temperature, thereby to go to waste.

Herein comes the action of the cylinder walls, as the redeemer of an otherwise bad situation. The temperature within the cylinder is so very high at the instant of explosion that the heat interchange with the walls is exceedingly active. The thin film of the interior surface attains a temperature probably from 1,000 to 3,000 degrees higher than that of the external surface. Therefore, no sooner has the working flame expanded and dropped appreciably in temperature than it finds the latter maintained by its envelope of very hot wall-surface. So hot is this surface and so active the return of the stored heat to the expanding gases that the latter frequently expand almost isothermally *at the maximum temperature permissible within the cylinder,* and in doing so succeed in returning to the piston, as work, an important fraction of the heat which the walls had already necessarily abstracted in order to keep down maximum temperatures and which would otherwise have been entirely wasted. So marked is this action that it is safe to say that, excepting the degree of compression, it is the one factor most active in making gas-engine efficiency what it is today.*

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* **Note:** See Trans. A. S. M. E. 1903, page 171, and the author's "Thermodynamics," pages 293 to 300, for further exposition of this fact. The substance of the argument stated in these references may be summarized as follows, referring to Fig. 1, which may be utilized to represent in entropy temperature coordinates the action of the Otto cycle. Therein let the closed figure *ABCD* represent the theoretic thermodynamic action of the standard Otto cycle, *AB* representing adiabatic compression, *BC* the rise of temperature and increase of entropy in combustion, *CD* the adiabatic expansion and *DA* the final cooling of the gases

It is therefore obvious that the gas-turbine has no opportunity to offer an advantage over the reciprocating gas-engine such as the steam-turbine offers over the steam piston-engine. This being so, is the development of a gas-turbine a desirable thing? If it is a desirable thing, is it possible? In reply, we would say that we think that it is desirable. Even if it is true that the device does not promise advantages equivalent with those offered by the steam-turbine, yet it still offers advantages, and for some special services it could offer peculiar ones which would be attainable by no other type of heat-motor.

As to the possibility, or rather the practicability, of the gas-turbine, that must be debated upon two lines—the thermodynamic and the mechanical.

Thermodynamically, there is no reason why a gas-turbine cannot be operated with as good an efficiency as any of the known heat-motors. It is first to be stated, however, that the standard Otto cycle is not the one applicable to the problem in hand. It is necessary to refer here again to the facts already cited—namely, that an important fraction of the motive power active in the expanding gases of the explosion-engine depends upon the fact that the gases are at work in the chamber in which they have just burned. The fundamental importance of this fact in the discussion is shown by the universal failure of all past efforts at the compounding of the explosive engine. These attempts have been made by men of unquestioned skill, have absorbed large sums of money, and have been made upon a scale commensurate with the importance of the problem, one such engine, at least, having been rated at over 600-horse-power. Yet they have all failed because of the collapse of the working gases so soon as they were divorced from the locality in which they had burned. Their high-temperature heat, coupled with small specific heat, proved to be entirely unreliable for the purposes of transmission from high-pressure to low-pressure cylinder. Since the operation of a gas-turbine

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during exhaust. The maximum temperature, at C, is egregiously greater than any permissible in a working cylinder, even if intermittent. Let it be assumed that ce is the maximum temperature-level possible. Then a water-jacket must be provided sufficiently active to reduce temperatures from C to c by the abstraction of heat. In doing so, however, there would be involved the complete waste of the heat measured by the area $nCcm$, or of the heat available for work $CcdD$, which last is an important fraction of the entire heat available for work, $ABCD$. This having been done, however, and the process of temperature-rise from combustion having been limited to Bc, the beneficial effect of the wall action is shown in its distortion of the ensuing expansion from the adiabatic cd to the almost isothermal cf, whereby there is returned to the working gases the heat measured by the area $mcgf$, or the heat available for work of cfd. In other words, the wall action brings about automatically a fair approximation to that isothermal flat top to the cycle which Mr. Diesel recognized as of such great value when he projected his heat motor.

upon the explosive cycle necessarily includes, so far as we can see, the combustion of the gases in one locality and their expansion in another, it will be taken as settled that the explosive cycle is out of the question.

The one other cycle naturally turned to from the Otto is the constant-pressure cycle, variously known as the Joule, the Brayton, etc. In this cycle the compression must carry the working substance adiabatically to the highest pressure of the cycle; then follows the addition of heat, presumably by internal combustion, under constant pressure and with increasing volume; then follows adiabatic expansion to atmospheric pressure as a quite separate process.

It is first to be noted, in connection with this cycle, that in order to compete successfully with its explosive rival, it must operate with practically the same pressure-range. For modern gas-engine practice of the best sort, this may be taken as from atmospheric to 400 pounds per square inch. Given a range of pressure and temperature equal with that of the Otto cycle, the Joule is far superior to it in efficiency; but when its pressures are limited to anything like those attained at the end of compression in the Otto cycle, it is a complete and hopeless failure, and would be even if carried out in an engine of ideal construction. It is this fact which explains the many recorded failures with the constant-pressure cycle in the past. The one temporary success, the Brayton engine, worked to 80 or 90 pounds per square inch; and when the Otto "Silent" engine appeared, compressing to 30 or 40 pounds per square inch and exploding to 150 or 200, the defeat of the Brayton was immediate. That even today there should still be put forth experimental turbines and piston-engines attempting to operate upon this cycle with working pressures of from 40 to 100 pounds per square inch is remarkable evidence of how blindly money is wasted in mechanical experiments, without regard to the costly failures of previous experience or to the plain dictates of thermodynamic science.

Given, however, a range of pressure and temperature equal to that of the Otto cycle, there is no thermodynamic obstacle whatever to the operation of a gas-turbine upon the Joule cycle with an efficiency superior to that of the explosive piston-engine. Since there has recently appeared in these pages, however, an article* by one of the authorities taking the opposite view, it is worth while to stop and controvert its error.

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* "Practical Investigations of the Gas-Turbine Problem," by Dr. Charles E. Lucke, April, 1905, page 96.

This error lies in a confused use of the term "free expansion." The free expansion of the expansion-valve of the refrigerating machine and the free expansion of the steam-turbine nozzle are assumed by Dr. Lucke to be the same process. Further, each of these processes is assumed to be a simple one. As a matter of fact, however, the two are quite different, and each is duplex in its nature. It consists primarily of a pure adiabatic expansion, developing the normal temperature-drop of adiabatic expansion and converting the normal amount of energy into velocity of flow. In both of the devices referred to, velocity of flow is no sooner attained to an appreciable degree than fluid friction is incurred, reconverting more or less of this normal quantity of energy into heat. But between the expansion-valve of the refrigerating machine, or the orifice of the throttling calorimeter, and the expansion nozzle of the DeLaval turbine there are two important differences, viz.:—

I. In the former the reconversion of energy into heat occurs upon such a scale that *all* of the mechanical energy developed in the adiabatic expansion is thus retransformed, whereas in the turbine nozzle the process is merely incidental and covers only that minor fraction of the energy handled which the most skilful design fails to avoid.

II. In the handling of saturated steam or ammonia-vapor, the increase of entropy involved in this dissipation occurs *without rise in temperature* (and in superheated steam nearly so), whereas in the handling of the permanent gases the reconversion returns the temperature almost, but not quite, to the original one at which adiabatic expansion began.

From the second of the two phenomena just mentioned Dr. Lucke has observed that the temperature-drop with permanent gases in frictional expansion is very slight. To this situation he applies the familiar formula for efficiency:

$$F = \frac{T_1 - T_2}{T_2},$$

although the latter holds true only with purely adiabatic cycles. Therefore, he concludes, frictional expansion is of no value for the gas-turbine, because it develops little temperature-drop. On the other hand, he observes, frictional expansion with saturated or wet vapors develops a marked drop in temperature. Therefore, he concludes, it would be (and in the turbine nozzle it actually is) of great value for power-development, offering the efficiency expressed by the above equation just as does adiabatic expansion.

It is hardly necessary to point out the error of this position. Frictional expansion is worthless for power-development, whatever may be the working substance or the device employed and whatever may be the temperature-drop which it develops. It occurs only when all of the heat which has been already converted into work has been subsequently reconverted into heat, with a thermal efficiency of 100 per cent. and a thermodynamic efficiency of zero. But the turbine nozzle does not embody frictional expansion, except as a quite minor and unavoidable detriment. Further, the temperature-drop which is available for doing work, and its efficiency, in adiabatic working is the same for any one substance and any given pressure-range, whether it be steam or gas, *without regard to whether the process be carried out in a cylinder, pushing a piston, or in a jet-producing nozzle.*

It is true that in actual practice the nozzle-expansion of the hypothetical gas-turbine may not be expected to develop a temperature-drop quite equal to the theoretic one of the pure adiabatic process; but the same must be said of the working expansion-cylinders of either the air-refrigerating machine or of the compressed-air motor (when not preheated), both of which Dr. Lucke attempts to contrast so strongly with the former. The latter two will incur slight in-leakages of heat in the form of heat, thus raising the terminal temperature above the theoretic; the former will incur a slight in-leakage of work in the form of heat, from fluid friction, to the same end. Instead of constituting a marked contrast they form a close parallel.

Therefore, it is to be repeated, the possibility of developing good thermodynamic efficiency in the gas-turbine, by maintaining nozzle or guide-blade expansion in either one or several stages, is an exact parallel with that of the piston-engine operating upon the same thermodynamic cycle; it is equally promising in theory—it equally involves constructive difficulties and detriments in practice.

Turning now to these constructive questions, it appears that the obstacles in the way of the gas-turbine lie in two directions, viz.:—

I. In the apparent necessity of expansive working from very high initial temperatures, with practically simultaneous development of power.

II. The constructive difficulty of compressing supplies to high pressure, either in rotary compressors operated at turbine speeds or in a reciprocating compressor operated by reduction-gearing.

As to the first, let us refer again to Figure 1. The outline cycle *ABCD* therein has already been used to represent a theoretically perfect Otto cycle, but it was originally drawn to scale to represent a theoretically perfect Joule cycle. It shows how the process of combustion *BC* would develop a temperature theoretically over 5,000 degrees F. and actually in the neighborhood of 4,000 degrees. It is at first sight impracticable to consider the injection of such a working fluid into a turbine, the vanes of which must practically attain the temperature of the gases (since the latter are not intermittent in their action), or temperatures somewhere intermediate between *C* and *D*. A second thought brings the suggestion that if we should develop all of our expansion in a single nozzle, as is done in the DeLaval turbine, we should then have to feed into the working parts a fluid having a temperature no higher than D. This suggestion has been largely worked upon, and considerable effort has been expended in trying to find some constructive material which would permit such a plan of operation. It is my opinion, however, that the outlook in this direction is not promising.

There is another way out of the situation, however. Let it be supposed that into the hot products of combustion of the Joule cycle, with its flame developed under high but constant pressure, there be injected a proper quantity of water, much as is done in the cylinder of the Bánki motor operating upon the Otto cycle. A much more stable method of accomplishing the same result was illustrated in The Engineering Magazine for February, 1904, page 667. The thermodynamic principle involved in either process is exactly that of the steam-boiler and furnace, except that in the latter the flame is under atmospheric pressure and transmits its heat to the water through the boiler-walls, whereas in the former the flame exists under the same pressure as the steam and transmits its heat to the water by direct contact. Further, in the latter the resultant product is pure water-vapor, whereas in the former the product is a mixture of steam with nitrogen and carbonic acid. Either process consists, thermodynamically, in an exchange of narrow entropy, or small heat-mass at high temperature, such as that indicated at the point *C* as the product of the internal combustion of the Joule cycle, for the wide entropy or greater heat-mass moving at a lower temperature or velocity, such as is indicated by the point *H*, of Figure 1. That is to say, the heat-area *OBCn* has been exchanged for the heat-area *OAFGHh*. In this particular case it has been assumed that the steam thus formed is appreciably superheated, the point *G* being that of saturated steam for the prevailing pressure.

If, now, this fluid be expanded throughout the same range of pressure as was originally contemplated, in any standard type of turbine, the adiabatic drop involved will be that shown by the line *HI*, as a substitute for *CD* of the dry-gas turbine. The cycle developed will be *AEFGHIKA* as a substitute for *ABCD*. The change has reduced our demands upon the working parts of the steam-turbine, as regards durability against high temperatures, from the temperature D or higher to something intermediate between H and I. It is true that the theoretic efficiency has been somewhat decreased. It has not been decreased, however, in anything like a proportion with the decrease in temperature. This is one of the errors fallen into by even so eminent an authority as Dr. Stodola.* That the actual efficiency attainable in practice, moreover, might be as great as or even greater than in the dry-gas turbine there is reason to expect from the following considerations.

It is to be remembered that the working fluid of the dry-gas turbine is one of very low specific gravity. Consequently, when called upon to absorb in kinetic form the full energy developed by its own adiabatic expansion, and especially if this must be completely performed in one stage, the resultant velocity will be enormous. This is one of the objections which has been urged as fundamental against the gas turbine, in more than one treatise upon the topic. The peripheral velocities which would be called for in order to properly develop mechanical energy from such a dry-gas jet would be far beyond those very high ones to which we have already become accustomed in steam-turbine practice. Moreover, since the one loss of turbine thermodynamics, friction, increases with the velocity, we could not expect the expansion in such a nozzle to remain so purely adiabatic as is the case with steam. The proportion of the theoretic efficiency practically obtainable would be much less than in the steam-nozzle.

In the case of the mixed fluids, however, conditions are quite different. The total amount of energy to be developed by adiabatic expansion is no greater than in the original dry gases; indeed it is somewhat less. At the same time, the molecular mass of the fluid has been very much increased by the intermixture of the steam. Therefore the velocity requisite to absorb the energy thermodynamically developed will be not only a mere fraction of that called for with the dry gases, but it will be even less than with pure steam. The beneficial effect of the process, therefore, upon peripheral and rotative velocities is obvious.* Volumes indeed would be somewhat greater than with pure steam, although less than with dry gases; but one of the prime characteristics of the turbine being the ability to handle large volumes without the usual cost in apparatus and friction, it may be taken as safe to dismiss this point as constituting no obstacle.

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* "The Steam-Turbine, with an Appendix upon the Gas-Turbine and the Future of Heat-Engines," Stodola, page 416.

In my opinion, the gas turbine is a machine immediately practicable, both thermodynamically and mechanically, with the sole exception of the question as to the compression of supplies; and this is a question in regard to which there is little to be said at present. The several paths to solution are plainly open to the constructive engineer. What he may be able to make of them is entirely a question of individual skill. That they will be developed and their obstacles properly overcome, with a little time and patience, there is but the slightest doubt. Indeed, the prime object of the present article is to point out clearly that in this mechanical field, and not in the thermodynamics of the case, lie the true obstacles. These last are numerous enough and rigid enough. It is desirable to forefend any more wandering abroad in useless endeavor against obstacles which do not exist, in place of concentrating all attention upon those legitimate ones which must inevitably confront effort, in so novel a field of invention as the gas-turbine.

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* The situation has been described in popular language as this: That each molecule of dry gas takes unto himself a wife (of steam) and is forced thereby to abandon his fast career and to settle down to a slower but more effective gait.

EDITORIAL COMMENT

THE Seventh International Railway Congress, held at Washington during the past month, was an event which demands comment for several reasons. It was the first meeting of the congress in the United States, and it was the first meeting of this important organization in which anything like a proportional part has been taken by American railroad men.

So far as the value of the professional sessions and papers is concerned, an examination of the proceedings and discussions must fully demonstrate that all departments of transportation will benefit greatly by the work of the congress. The reports presented were divided into classes, according to their relations to track and works; to locomotives and rolling stock; to operation; to light railways; and to general matters. Each of these classes contained several subdivisions, and numerous voluminous papers were presented, the entire proceedings constituting a mass of valuable matter upon the important present problems in railroading.

Of the great value of a systematic discussion of these questions by a gathering of nearly one thousand specialists, representing all countries in which railways are scientifically operated and studied, there can be no doubt; and while the congress itself lasted but ten days, its works will follow it, supplemented as it was by a notable exhibition of American railway appliances and by extensive tours of the visiting delegates to all parts of the country.

This is not the place to consider in detail the work of the congress, but attention may be called to the fact that among the subjects discussed were some of distinctly international significance. Thus, the four-cylinder balanced compound locomotive, just beginning to receive serious consideration at the hands of American railroad engineers, has been firmly established in Europe for a number of years, thanks to the brilliant pioneer work of such men as De Glehn, Du Bousquet, and others, and the hesitancy of some American railroad men in discussing the value of such engines was in marked contrast to the assured confidence of the European engineers who have had the benefit of favorable experience.

Again, the hitherto unquestioned reign of the Stephenson link motion is being disputed in the United States by the successful applications of the Walschaert valve gear, a motion which, on the Continent at least, has long since held the first place as an effective means of operating the slide valve by a simple mechanism entirely outside the frames. If these features alone become impressed upon American railroad practice, the educational value of the congress, so far as the United States is concerned, will have been fully demonstrated.

The relation of light railways to main trunk lines, and the extent to which they may be profitably utilized as feeders, was another topic, and the practical experience obtained in Austria-Hungary demonstrated the wisdom of encouraging, instead of antagonizing, such adjuncts to the comprehensive problem of transportation. In this connection the employment of motor cars as auxiliaries in railroad operation was brought out, and there is little doubt that this department of work will occupy a much greater portion of the deliberations of the next congress, five years hence in Switzerland.

* * *

It is to be hoped that the auspicious beginning made at this congress will continue, and that American railroad men will hereafter broaden their horison, and enter more fully into the development of their profession in other parts of the world. The railroad engineer, probably by reason of the intense application demanded by his work, has a marked tendency to become self-centred to a high degree, and to pay far too little attention to what is going on outside of his immediate circle and land. From this position it is but a short step to that of isolation and to the acquirement of the idea that the practice with which he is surrounded is the best possible to be had. It does such men good to be brought into close contact with men of other lands, and to find out that the things which they are trying to do are being done as well, and sometimes better, by others who may be employing entirely different methods.

* * *

Mr. Lindon W. Bates' project for the Panama Canal, to which we referred very briefly last month, has been since then fairly presented in several of the weeklies and perhaps is already so well understood as to need no recapitulation. Briefly, it differs from preceding projects—all of which he rejects—in the following essential points:—

1.—He would extend the summit level (at an elevation of about + 20 feet) entirely across the isthmus from tide to tide, by throwing low barrages across the valleys of the Chagres and the Rio Grande. This would give two terminal lakes, to be joined of course by an excavated central canal section; the projects heretofore advanced have contemplated a central summit lake, placed between two tide-level canal sections. The terminal lakes in the Bates project would be entered and left by twin locks, directly at the terminal seaports, these locks being placed in solid ground away from the undersluice-regulated barrages, and radical changes being made in the proposed disposition of the harbors to meet the new location. In the main, these lakes would receive directly and regulate sufficiently the inflow from the lower tributary streams, though special regulating works would be provided for the Rio Cano. A "B" variant from his "A" project combines with it the already familiar summit lake, at an elevation of about + 50 feet, but the former project is the one which Mr. Bates regards as the best solution.

2.—He would control the upper Chagres by comparatively low, undersluice dams at Gamboa and Alhajuela, instead of by high, impounding dams with spillways at the same points. Thus the regulating basins behind the dams would be normally empty, instead of normally full, as always heretofore proposed. A further feature of his plan is the excavation of a considerable basin at Obispo, immediately below the Gamboa dam, in which the regulated flow from the upper Chagres can be received, and directed, one-half toward the Pacific and one-half toward the Caribbean, through channels of compensated water-section.

These appear to be the salient differences between Mr. Bates' project and any other which has been proposed, and it is manifest that they are so fundamental as to make a wholly new mode of attack upon the problem. Supposing it to afford a solution of the essential conditions, it seems to promise many important advantages. From the point of view of navigation, it makes the lockage time coincident with the necessary delays at the canal terminals, and it affords comparatively free lake navigation for about 17 miles of the total transit—nearly 5 miles more than would be afforded by Lake Bohio at the 90-foot level. From the point of view of construction, it reduces the dams to so low a head that foundation difficulties almost disappear, and it utilizes to the maximum the work already done by the French company. From the point of view of sanitation, it drowns most of the swamps near the terminal cities and thus remove one of the most prolific causes of disease.

It will almost inevitably strike the reader, however, that Mr. Bates takes surprisingly little cognizance of the huge excavation demanded by his plan. The quantities would certainly be an extremely large fraction of those involved in a sea-level canal, which he elsewhere characterizes as "too appalling to contemplate." And beyond this, the supreme and vital question is:—would the projected regulation works meet the requirements of the regimen of the Chagres and the assured and uninterrupted navigation of the canal, under conditions of maximum and of minimum rainfall? To our minds, Mr. Bates does not present a convincing demonstration on these points. It is a matter in which the most careful and accurate quantitative analysis of the data is essential This Mr. Bates may have made, but it does not seem to us to be presented in his monograph; and until it has been thus rigidly tested, no project can be more than an interesting possibility. Certainly Mr. Bates' project offers many advantageous features, and if feasible and adequate to the conditions, deserves most careful consideration; but the only thing to be done is to commit it to the board of consulting engineers, for critical but impartial examination.

* * *

THE appointments of Gen. Henry L. Abbot and Mr. Isham Randolph to this advisory board, just announced, are cause for general satisfaction and sincere congratulation. Mr. Randolph brings to the work a fund of practical experience in the successful handling of closely similar problems, while General Abbot is unquestionably the highest authority on the climatic data of the Isthmus and the all-vital problem of the Chagres. It has been our pleasure and privilege to present some of his most important studies. We rejoice with the country that his fund of knowledge is to be made so fully available in the conduct of the great national enterprise.

* * *

THE purchase of materials for the Panama Canal is likely to play an unforeseen part, in putting the tariff-revision question upon a new basis, or at all events in a new light. The few figures cited by the Commission, to show how much they could save in cost of the canal by buying certain items abroad, have done more to enlighten the country upon the effects of the tariff and trust combinations than all the statistics of all the campaign orators since the tariff was made a party issue. Figures of the prices of steel rails at home and abroad, showing the excess burden of $6.00 a ton borne by the home buyer, have been made as familiar as the proverbial household words; but how many householders are ever interested in buying a steel rail? Here, however, is a great National undertaking in which each of us has his part and for which each is to pay his share. The sense of proprietorship enters, and policies and their effects become acutely interesting.

It is already made clearly apparent that many of the materials and some at least of the equipment can be bought much more cheaply in foreign than in home markets—sometimes even when they are originally of American manufacture. What are we going to do about it? Shall the Commission treat this phase of the construction just as we have been assured they will every other, with every energy centered upon the utmost economy and efficiency in construction—upon building the best canal for the least money, and therefore with a free hand to buy in the cheapest market! Manifestly, that would be the course of any independent construction company. It would be the reasonable business policy. But is it the right policy for a Government committed to the "protection of home industries"? If they adopt it, are they not admitting that protection and its concomitants have produced conditions unfavorable to the economy of constructive work, from which it is advisable to escape whenever possible, and which, therefore (by natural inference) it would be well to remove from the country at large by abolishing the causes?

On the other hand, if they reject all foreign bids and buy in American markets at the greatly advanced prices cited, are they not manifestly burdening the work, in its present cost and its future earning power, with a large expenditure which might plainly have been avoided? Will it not be apparent that this addition to the cost, while it must be paid by the country as a whole, will go to the immediate benefit of a very few—practically, the United States Steel Corporation—and will not that of itself dampen the popular ardor for the present tariff ?

Whichever horn of the dilemma be grasped, the tariff seems likely to come sharply into question; and the novelty in the matter is that the burden of proof seems to be thrown upon the "stand-patters."

* * *

We have reviewed elsewhere in this issue a paper upon high-speed railway trains, this being based upon the regular running speeds of some of the most noted trains of Europe and America, not taking into account special trains or phenomenal spurts which have been made independently of regular operating schedules. At the same time it is interesting to note that within a few days the train cited as the fastest train in the world, by the author of the paper referred to, the Atlantic City Flyer of the Philadelphia and Reading Railway, has beaten its own record upon the interesting occasion of the transport of a number of the delegates of the International Railway Congress to Atlantic City.

The regular running time of the train over the distance of 55.5 miles from Camden to Atlantic City is 49 minutes, an average rate of 67.9 miles per hour, this requiring speeds of more than 70 miles per hour for portions of the run to make up for the delays near the terminals. The train carrying the delegates of the International Engineering Congress made the run on May 14 last in 43 minutes, this giving an average speed of 77.4 miles per hour, with correspondingly higher speeds during parts of the trip.

Although these high speeds may often be considered as pertaining to the advertising element in railroading rather than to legitimate transportation, it is none the less certain that such trains do attract passengers to the roads on which they are run. The Atlantic City Flyer is patronized during the season by hundreds of passengers who use it regularly for transportation between Philadelphia and their summer homes by the sea, and in this way it has become recognized as a regular feature of the road. In like manner the Empire State Express, referred to in Mr. Kramer's paper as the fastest regular train for distances greater than 300 miles, has proved sufficiently satisfactory as a business proposition to cause the New York Central Railroad to add another similar train to the daily schedule. The question as to whether high-speed trains pay or not can be answered only by making the experiment and leaving the answer to the traveling public; and in these two cases, representing the two fastes trains in America, the response appears to have been wholly in the affirmative.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

PROGRESS OF THE PANAMA CANAL.

REPORT OF THE CHIEF ENGINEER UPON THE PROGRESS IN ENGINEERING AND CONSTRUCTION WORK AT THE ISTHMUS.

John F. Wallace—Isthmian Canal Commission.

THE report of the Chief Engineer of the Isthmian Canal Commission, published in pamphlet form by the commission and reprinted wholly or in part by the technical press, forms a document which, both by its official nature and its contents demands critical comment and review. The report brings the work down to February 1, of the current year, and includes abstracts of the reports of the several engineers who have been engaged at various points along the route during that period. These abstract division reports form the opening portion of the main document, and some of the more important features which they contain will be given, as upon them the general conclusions of the Chief Engineer are based.

After considering the report of Mr. List, concerning the harbor works at Colon, which present no serious difficulties, the investigations of Mr. Nichols at Gatun are taken up, these being mainly devoted to the examination of the valley of the Chagres in the vicinity of Gatun to determine the possibility of the construction of a dam at that point. The borings which have been made here, and further up the valley of the Chagres river, appear to show that the general nature of the route is that of a deep gorge filled with alluvial deposits and freely water-bearing material at such depths as to demand great caution in the selection of a site for a dam.

"The results of all the studies in the Chagres valley from Gamboa to Colon clearly point to the existence of a geological gorge, the bottom of this gorge being at an unknown depth between Colon and Bohio, but coming to within 163 feet below sea level at Bohio, and gradually rising to the level of the sea in the vicinity of Gamboa, borings having been made to a depth of 175 feet below sea level without discovering solid rock in the vicinity of Gatun."

Investigations made by Mr. Dose, resident engineer at Bohio, upon the practicability and cost of a high dam in that vicinity have been directed to two sites which appear to offer possibilities. Borings here show that there is little probability of finding satisfactory locations, since it would be necessary to go down 163 to 168 feet, and for at least 150 feet the soil is very porous and water bearing. Investigations at Buena Vista, farther up the valley, appear to indicate rock bottom at about 130 feet below sea level, but the borings at this point are not yet completed.

Mr. Wallace lays much stress upon the investigations in the vicinity of Gamboa, the work there having been done by Mr. Ehle to determine the possibility and advisability of a dam in that neighborhood, together with the construction of a tunnel spillway through the continental divide into the Pacific ocean. The results of these investigations are as follows: The construction of a dam up to the height of 200 feet at Gamboa is practicable and economical, bed rock being found at an elevation of approximately the level of the sea, and the configuration of the ground above the sea level giving a cross section of the valley of moderate and reasonable dimensions at this point. It is also considered possible to construct a tunnel spillway either through the continental divide to the Pacific slope with a maximum tunnel length of eight miles, or a tunnel spillway to the Caribbean slope with a maximum tunnel length of 3½ miles.

Mr. Wallace considers that the data obtained clearly demonstrate that the construction of a dam at Gamboa will satisfactorily and economically solve the problem of the control of the Chagres river, the provision of water for any low level lock-canal designed, and the supply of sufficient electric energy for lighting purposes, railroad operation, or the operation of machinery used in the construction of the canal, and he estimates that, for the construction of the Gamboa dam, including the Pacific spillway, $17,000,000 would be required.

The Culebra cut seems to have lost much of the terror with which it was formerly regarded, and it appears to be rightly considered that the real problem in the undertaking lies in the control of the Chagres river. At the same time it is doubtless correct to state, as Mr. Wallace does, that the excavation at Culebra practically controls the time required to complete the canal, since all the other works can be completed in the time required for the central Culebra division. A canal on the 60 foot level will require the removal of 111,000,000 cubic yards of material from Culebra, and this will be increased to 142,000,000 cubic yards for the 30 foot level, and to 186,000,000 for a sea-level canal. Mr. Wallace says that it seems safe and conservative to say that the summit level should not exceed 60 feet in height, but he also maintains that it is "self-evidently true that a sea-level canal is the most desirable in economy of maintenance, operation, time of passage through it, and simplicity of design, plan, and execution; that as a problem *per se* it is the only solution, the deterrent factors being time and cost."

Broadly the recommendations of the chief engineer at this time, for the favorable consideration of the commission are as follows:

1. That harbor facilities be at once provided in the vicinity of Colon by the construction of an inner harbor at Cristobal-Colon and by the construction of a breakwater at least 4,000 feet long, to protect the east side of the outer harbor.

2. That the work of completing the Gatun diversion be proceeded with at once.

3. That the location of a dam with the crest approximately 200 feet above sea level be decided upon at Gamboa; and that the work of construction be organized and commenced as soon as the plans for such structure have been approved by the commission.

4. Considering the fact that the Panama canal is intended to serve the commerce of the world through centuries yet to come; that it is not a commercial enterprise to be carried forward for the immediate benefit of the present generation; that the American nation haas voluntarily undertaken this great work, and that the question of merely a few years of time or a few million of dollars of cost more or less, should not be controlling factors, it would seem proper to treat the problem from a broad and liberal standpoint. Therefore, it is recommended that no temporary or tentative plan be adopted that will interfere with the final adoption of the sea-level plan, which it is hoped will ultimately receive the favorable consideration of the commission.

The report is characteristically direct and definite. It was, of course and properly, Mr. Wallace's purpose to state his propositions concisely, and not to argue them. By those to whom the same conclusions are not so clearly apparent, however, it may be regretted that the statement is necessarily so brief. It is not self-evident, for example, why the rather important item of retaining walls at the Culebra Cut becomes no greater in the sea-level than in the 60-foot-level estimate. More important, it is not quite apparent why the item of "Chagres and Gatun Diversions," fixed at $3.000.000 for the 60-foot level, remains at the same figure in the sea-level estimate; for in the latter case it would seem that the entire run-off of the Chagres valley below Gamboa—about one-third of the total discharge of the river—must be provided for outside of the canal, instead of being in large part received into the summit lake. And while

Mr. Wallace feels that the proposed control of the Chagres by the Gamboa dam and tunnel spillways "does not present any engineering problems that have not been already satisfactorily and repeatedly solved in various parts of the civilized world," those less accustomed to the project feel considerable anxiety concerning it—especially the feature of the assured control of a torrential river by an eight-mile tunnel through the character of formation existing on the Isthmus. And there still remains the whole watershed below Gamboa to be controlled, including the by no means insignificant Rio Cano.

We have no doubt whatever that Mr. Wallace can support his recommendations ably. We believe that one strong ground of his faith is the conviction that the sea-level canal is the ultimate ideal, and therefore that an engineering solution must be found for all the difficulties in the way. If indeed it be "self-evidently true that a sea-level canal is the most desirable in economy of maintenance, operation, time of passage through it, and simplicity of design, plan, and execution, so that as a problem *per se* it is the only solution"—then the case may be closed; but the evidence has disclosed itself differently to other very able students and specialists. Simplicity of design, stability of maintenance, facility of execution, have seemed to other engineers of the very highest standing to rest with one of the summit-lake plans. Here, too, they have found not only the enormous reduction of the great problem of the Culebra Cut, but in their judgment the most complete solution of the problem of the Chagres. And in the free navigation afforded by the summit lake for a large portion of the transit distance, they see a factor throwing the advantage of shorter time of passage and safer navigation also to the summit-level type.

It is doubtless in recognition of this that Mr. Wallace has chosen the broad-minded course of consulting with an international board of engineers particularly experienced in the problems of ship-canal management and navigation. We shall hope that the complexion of this board will be such that Mr. Wallace, quite as much as the country at large, will feel that the very best special knowledge and experience the world affords has been placed at his disposal for consultation and guidance.

RECENT PROGRESS IN METALLURGY.

A REVIEW OF THE DEVELOPMENT OF METALLURGICAL PROCESSES AND APPLIANCES DURING THE YEAR 1904.

H. Le Chatelier—Bulletin de la Société d'Encouragement.

IN accordance with the practice of the Société d'Encouragement pour l'Industrie Nationale there is contained in its *Bulletin*, and in its associated publication, the *Revue de Métallurgie*, from time to time reviews of the current development in the various departments of applied science. In a recent issue of the *Bulletin* we note an address by the well-known metallurgist, M. H. Le Chatelier, upon the progress of metallurgy during the past year, and from this comprehensive review we make some abstracts.

M. Le Chatelier calls attention to the fact that progress is made along two different paths, the one following studies in pure science, of which the application does not always immediately appear, and the other covering work which, while sometimes empirical, leads directly to results of practical importance and value. Both of these roads, however, lead to the same ultimate goal, and in many instances they approach very closely to each other. Thus, the practical man sees but little value in the researches of metallography, concerning which so much has been said and written of late, but it is none the less apparent to those who study the subject that this method of investigation is destined to lead to valuable practical results. That this is the view of men of hard practical views is seen by the fact that some of the largest manufacturing establishments have installed the methods of micro-photography into their laboratories.

The fact that steel is constituted in a manner similar to the rocks of which the surface of the earth is formed, is now generally accepted, and the use of the microscope has shown that there are three principal constituents: ferrite, or pure iron; graphite, or pure carbon; and cementite, a carbide of iron. The various forms under which these three constituents appear have been the subject of much discussion, and the whole question of the study of the constitution of tempered steels is now in the hands of an international committee including in its membership some of the most eminent metallurgists of France, England, Germany, Sweden, Russia, and the United States.

The methods which have been applied with success to the study of the constitution of steel have also been used in investigation of bronzes, and it is believed that, by a combination of thermal, chemical, and metallographical methods important results will be obtained.

One of the most curious discoveries in the domain of metallurgy during the past year is that of Dr. Heusler in connection with the existence of magnetic alloys formed entirely of non-metallic elements. Thus an alloy of aluminum and manganese exhibits a coercitive force equal to about one-half that of iron. The alloy is too brittle and unstable to have any industrial value at present, but its discovery may lead to further developments of practical importance.

Among recent investigations of importance may be noted the studies of Boudouard and of Hahn upon the chemical reactions which occur in the blast furnace. The equilibrium of the blast furnace is a subject of the greatest industrial importance, and the relations of carbonic oxide, carbonic acid, vapor of water, and hydrogen to each other and to the solid carbon are only beginning to be understood.

There has been a notable increase during the past year in the application of the methods of electro-chemistry to the analysis of metals and materials of metallurgy. The use of the electric current enables numerous sources of error due to reagents to be avoided, while the employment of rotating electrodes has permitted a great increase in the quantity of deposited metal, by bringing the surfaces of the cathode continually into contact with fresh solution.

During the year there has been much important work done in the investigation of special alloy steels, and the studies of M. Guillet in this field have been especially noteworthy. To these must be added the excellent work of M. Guillaume upon the nickel-steel alloys, with especial reference to the control of the coefficient of expansion, both in the production of the alloy invar, of minimum expansion, and of the alloy platinite, having the same coefficient of expansion as platinum.

The discovery of high-speed tool steel, by Messrs. Taylor and White, dates back to 1900, but some important studies upon later steels of this class have been made during the past year. The papers of Mr. Gledhill, and the experiments by Professor Nicolson, as well as those of M. Demozay, have shown very clearly the extent to which such steels may be employed to accelerate the rate of production, and the dynamometric experiments of Professor Nicolson give valuable data for use in connection with the design of new and more powerful machine tools to enable the full possibilities of the new tool steels to be achieved.

In connection with methods of testing materials the most important advances have been made in connection with researches into the fragility, or brittleness, of metals. By the use of notched bars of small size, so that the stress is localized and the fracture effected by a single blow, it has been found possible to determine very closely the resistance to shock, and thus an important structural property of materials may be investigated. The improved method of Fremont for determining the elastic limit may be noted, this consisting in the subjecting of a pyramidal test piece to tension or compression, one face of the pyramid being brilliantly polished, and revealing, by the extent to which this surface is dulled, the location of the section corresponding to the elastic limit.

Along similar lines may be mentioned the researches of Professor Arnold upon the behaviour of metals under rapidly alternating stresses, these repeating in an experimental manner the theories of Wöhler. There is an undoubted tendency to assimilate the methods of testing materials to the conditions which obtain in actual service, and the progress along these lines is evident.

The most important development in connection with the manufacture of iron is found in the Gayley process for supplying dry-air to the blast, removing the moisture by refrigeration. Practical tests have shown a saving of 20 per cent. of fuel by the removal of the moisture from the air supply of a blast furnace, but M. Le Chatelier calls attention to the fact that this corresponds to an average saving of only about 10 per cent., since the air is excessively humid for only about six months in the year. Nevertheless, he admits that the value of the improvement may be placed as second only to that of the introduction of the hot blast.

The principal development in electrometallurgy during the past year has been in connection with the electric manufacture of steel. The cost of the electric smelting of iron renders the process unable to compete commercially with the older methods, but the refining of high-grade steel, especially when the electrical energy is generated from the waste gases of the associated blast furnaces, is altogether within the bounds of commercial possibility. The results which have been attained at La Praz, and at Gysinge, and the report of the Canadian Commission, show that steel produced by electrical processes may compete successfully with crucible steel produced by the older processes.

Broadly, the developments of the past year in the domain of metallurgy show a general tendency toward an increase in the power and productive capacity of the apparatus and the workshop. The output of blast furnaces and of rolling mills has increased, while the use of high-speed cutting tools in more powerful machines has correspondingly increased the productive capacity of manufacturing machine shops. The economic effects of such changes remains to be seen, and the possibility of over-production, with consequent lowering of prices, may not prove to be a commercial benefit. It is not impossible, however, that serious effects may be prevented by suitable agreements among manufacturers, while the extension of applications of the products and the consequent development of new markets will naturally follow.

UNSOLVED PROBLEMS IN ELECTRICAL ENGINEERING.

AN EXAMINATION OF SOME OF THE QUESTIONS UNDER SCIENTIFIC INVESTIGATION IN THE DOMAIN OF APPLIED ELECTRICITY.

Col. R. E. B. Crompton—Institution of Civil Engineers.

IN the course of the James Forrest lecture, recently delivered before the Institution of Civil Engineers by Col. R. E. B. Crompton, some of the important problems now being attacked by electrical engineers were discussed in a very interesting manner, and some abstract of the lecture will be found of value both for its direct interest and also for its suggestiveness to engineers and students.

Col. Crompton divides his subject into two parts, one dealing with the electrical problems which have been set for us by Nature, and the other including the questions which have arisen in the course of the efforts of engineers to use electrical energy for the service of man. The first class of problems naturally fall more especially into the domain of the physicist, especially the examples selected by Col. Crompton, the problem of lightning discharges, and the questions connected with the subject of terrestrial magnetism. Following upon these, and forming what may be termed a sort of connecting link between the work of the physicist and that of the engineer comes the subject of the etheric transmission of power.

"The development of electric-wave telegraphy is an excellent instance of the various stages of the solving of an electrical problem. In this case Maxwell and Hertz settled the first stage and formulated the laws of the transmission of etheric waves. Branly supplied an important element when he invented the coherer. Marconi's enthusiasm, skill, and perseverance, aided by Fleming and other numerous competent co-workers, have carried the third stage to its present development.

"We may consider that the etheric transmission of signals up to a given distance, and notably for the purposes of signalling to and between ships at sea, is practically solved, although there are many secondary problems arising out of it. No doubt the first and most important of these is the production of wave-trains sufficiently powerful and of the right character to yield the best results. Fleming has particularly devoted himself to this subject, and the value of his inventions has been fully acknowledged by Marconi.

"Taking the economical question first. Fleming has shown that in all probability the method that we have arrived at, at our present stage of development, to communicate waves to the ether by the oscillating discharge of condensers only extends over probably about 1 per cent. of the time available; in fact, that we only have a series of intermittent waves with long vacant spaces intervening. What we require is a better method of originating a continuous train of waves rather than these intermittent ones; and here we can formulate our problem, which may be solved by the mechanical engineer or probably by the electro-chemical engineer. None of us has as yet succeeded in constructing an alternator with a frequency approaching 1,000,000 per second; but who can say that recent developments in extremely high-speed turbogenerators of the De Laval type may not furnish us with a good start in obtaining such frequency by mechanical means? Again, turning to the possibilities within reach of the electro-chemist, very promising attempts have already been made by Lodge and others to produce electrical oscillations from condensers charged by a Cooper Hewitt mercury vapour lamp. Duddell has shown by his investigation of the singing arc that herein lies a method of producing a continuous series of discharges, although in this case the frequency obtained is not sufficient for our purpose. At any rate, the solution of this problem of continuous operation by means of Hertzian waves appears to be extremely hopeful, and, at any rate, it is one of first importance."

Passing to problems more directly within the field of the engineer, one of the broad group of questions with which nearly every class of electrical machinery is concerned is what Col. Crompton calls the problem of "core and coil." In considering this it is interesting to note the analogy to steam engineering, the electromagnet bearing the same relation to electrical machinery as the cylinder, piston, and crank do to the steam engine. Wherever we wish to translate mechanical into electrical energy, or electrical back into mechanical energy we are compelled to use the "core and coil."

So far as the core is concerned, the problems connected with its construction have developed with its use. The early cores were made of the best quality of pure forged iron, but for commercial reasons it became necessary to employ a material which could be cast into the required shapes. After preliminary experience with cast iron the advantages of steel castings became apparent, but with this have come the losses from hysteresis and from eddy currents, and the present core problems are mainly concerned with the efforts to minimise these effects. The addition of silicon, suggested by Barrett, has been found to improve the homogeneity of the material, but further improvements are to be desired. The present requirements may be formulated as follows.

"Maximum of homogeneity, permeability, low hysteretic coefficient, high resistance as a mass to eddy currents; of course, all these combined with sufficient mechanical strength to resist the mechanical stresses due to centrifugal forces when the core forms part of the revolving mass, or to the stresses set up by magnetic attraction when the core forms part of the frame of a stator or magnetic ring of large dimensions. In the other class of cores, particularly those subjected to alternating electrical stresses, such as the cores of transformers, we cannot hope to obtain sufficient freedom from the losses due to eddy currents by means other than minute subdivision—that is to say, by lamination, or in some cases by forming the cores of a bundle of individual wires. Great progress has been made in the production of such laminated material, and a great part of our constructive work lies in the organisation of the labour necessary to fit together the large number of sheets or stampings which go to form this class of cores. Where such cores are used for revolving armatures, we meet with the secondary problem of securing satisfactory balance of the rotating mass, and it is not easy to obtain this, as any turning or cutting process applied to the edges of the thin sheets has a tendency to bring them into electrical conducting contact at the edges and ends, facilitating the eddy currents."

The coil which is wound about the core, has in like manner developed new requirements with progress in service. Thus, the early electro-magnets were made with coils formed of wire of round section wrapped with silk or cotton insulation, but this gives a mass of low conductivity, with entrapped air spaces, so that the escape of heat is difficult. Later attempts have included stepped windings, and windings with copper strip, but there is still room for much improvement, both in the preparation of the material for winding and in the insulation.

Another problem which is only partially solved is that of the electric storage battery. Col. Crompton is a believer in the great value of the accumulator even as it is now made. and he called attention to the marked improvements which have been made during the last fifteen years, especially in the reduction in cost of maintenance. At the present time the most economical equipment for small isolated plants for variable supply is a combination of an internal-combustion engine with suction gas producer, working for long hours and thereby charging storage sufficient to deal with the bulk of the load, but supplying the short hours of peak load from steam plant specially designed to work for short hours at a maximum efficiency. As for further improvement in the storage battery itself, Col. Crompton thinks that may lie along the line of standardisation, both in the batteries and in the means of charging them.

In regard to the great problem of electric traction on main-line railways, this is an entire department of engineering in itself. It is doubtless possible that higher speeds may be obtained with electric traction than are now common. but there is no reason to believe that these may not be met by correspondingly high speeds with steam locomotives of improved design.

The questions involved in the improvement of electric-lighting methods are touched upon in the lecture, as well as the problems connected with the improvement of electrical measuring instruments, and both of these fields offer abundant opportunities for effective work.

"A problem of real moment to both suppliers and users of electrical energy would be the discovery of a direct method of producing artificial cold by electrical means. If we had a ready means of producing artificial cold so as to obtain cold storage in our larders and so preserve our perishable foods, vegetables. and fruits. it would obviously greatly add to the pleasure of our lives and to the economy of our housekeeping. Of course, we can now produce artificial cold by connecting an air-compressor to be driven by an electric motor, and by expanding the air into the cold-storage chamber; but the method is costly and cumbrous. Probably something may be done by a well-designed high-speed air-compressor. but the real solution we are looking forward to is a direct method of producing cold from the electrical energy in our supply mains; and this probably is a problem for the electro-chemist. as we may conceive the apparatus taking the form of a battery abstracting heat from the surrounding air."

Broadly the work of the electrical engineer has been of profound influence in modifying other departments of engineering. and many of the improvements in prime movers. in workshop methods, and in all the departments of mechanical engineering especially. have been due to the requirements and demands originating in the development of electrical engineering.

"Finally, the greatest problem of all, and the one which will have the most profound influence on the well-being of our fellows. is the satisfactory development of our power schemes by which we hope to send the population back to the land. Power-distribution schemes of various degrees of magnitude have already been started in many countries. In those where water-power was available they have made considerable progress; but in this country, where we have to look to the generation of our power from fuel. the series of problems involved are of the highest interest, are extremely hopeful of speedy solution, and the social consequences that will follow on them are likely to be so important to the health and better development of our race that they deserve the most careful consideration of our best men.

"We already see that the necessity for bringing our working population into huge factories, so that they may work within the range of power allowed by revolving shafting, is already at an end; that nearly all power can be supplied through electric motors, and therefore the factory units themselves can be small, spaced more widely apart, and many classes of manufacturing processes can be carried out most perfectly in the worker's own home aided by the other members of his family.

"Already in Switzerland, France, and Germany trades are being profitably carried on under conditions very closely approaching those that have been foreshadowed to us by the promoters of garden cities. A large proportion of our workers can carry on their business at home in a workshop attached to the dwelling-house, and separated from the neighbour by the garden in which the children can grow up under the best conditions of light, air, and sunshine. The electrical engineer, who has been a chief cause in bringing about this vast social change, will be honoured among those who have really benefited mankind."

THE STABILITY OF MASONRY DAMS.

A REVIEW OF RECENT MATHEMATICAL THEORIES CONCERNING THE POSSIBLE WEAKNESSES OF EXISTING STRUCTURES.

Prof. W. C. Unwin—Engineering.

THERE has recently been some stir in engineering circles concerning the development of what has been termed some disregarded points in the stability of masonry dams, this interest having been largely created by reason of the application of a theory, developed about a year ago by Messrs. Atcherly and Pearson, to the great dam on the Nile at Assouan. Various editorial comments have appeared, notably in the pages of recent issues of recent issue of *Engineering* gives a valureview of the accepted theory of the stability of dams, with some added methods of computation, by Professor Unwin, in a recent issue of *Engineering* gives a valuable résumé of the whole subject.

As a matter of fact, the subject was brought up by reason of the proposition to raise the height of the Assouan dam, and after a visit of inspection at the structure, Sir Benjamin Baker reported that it was inadvisable, for the present, at least, to proceed with the project of raising the dam 20 feet. It is said that Sir Benjamin Baker stated to Sir W. Garstin, that this recommendation was due in part to a consideration of the theory advanced by Messrs. Atcherly and Pearson, and however this may be, there has appeared in the technical press a sudden interest in the combined subject of a University College paper and the safety of the Assouan dam.

Without going into details of a highly mathematical treatment of the subject of stability of dams, it will be sufficient to state that the usual theory, as developed by Rankine and others, assumes but two ways in which failure may be expected: by sliding bodily off its foundation, or by overturning about some part near the toe, the separation taking place practically along a horizontal plane. It is also considered necessary that no tension should take place in the masonry of the structure, and this condition is fulfilled by observing the same rule as obtains in the proportioning of masonry arches, namely, by using such proportions as shall keep the line of resistance always within the middle third of the structure.

The investigations of Atcherly and Pearson, however, show that under certain circumstances the internal stresses may be such as to render rupture along a vertical line liable before failure by horizontal separation could occur, and the factor of safety against failure by vertical rupture appears to be only one-half to two-thirds that which has been taken as existing against horizontal rupture.

In examining this paper of Messrs.

Atcherly and Pearson, Professor Unwin calls attention to the fact that the distribution of stress on horizontal sections appears to have been merely assumed by the authors. As Professor Unwin says: "It is attempted to be shown that the really dangerous sections are vertical sections, and that on vertical sections of existing dams an alarming amount of tension exists."

Thus Messrs. Atcherly and Pearson say: "Whether we judge by the line of resistance lying outside of the middle third, or by the existence of serious tensile stresses, or by the magnitude of the mean shearing stresses, the vertical sections are critical for the stability in a far higher degree than the horizontal sections." Again quoting Professor Unwin: "It would be a very serious thing if these conclusions were true."

That they are true, Professor Unwin seems to doubt, and at the same time he admits that the ordinary theory of masonry dams is incomplete, because no attempt is made to determine the distribution of the shear on the horizontal sections. This distribution has not been attended to by the French engineers, and is not satisfied in some of the earlier French dams, and in a paper on the failure of the Bouzey dam, at Epinal, Professor Unwin himself showed several years ago, that there were reasons for regarding tension on horizontal sections as especially dangerous.

"All theories of dams must proceed on the assumption that the dam is a homogeneous elastic solid. As a matter of fact, dams are so constructed of rubble masonry, with strong cement mortar, that they are practically monoliths. They have no plane joints, and there is no reason for supposing that they cannot withstand a reasonable amount of tension in any direction in the mass. But it probably is desirable that there should not be tension on horizontal sections, at any rate on the water face. If any progress is to be made in the theory of dams, it must be by finding a method of determining the distribution of the shearing stress on horizontal sections."

Professor Unwin himself has devised a semi-graphical method of determining this distribution of shearing stress, and this he discusses briefly in his paper. The method of computing the compression and tension stresses generally adopted is briefly reviewed by Professor Unwin, and he sees no reason to doubt the correctness of the determination hitherto adopted for such structures.

Extending the computation to the shear on any horizontal section he shows how its distribution may be determined for vertical sections at any points upon the selected horizontal, the diagram which he constructs giving a complete knowledge of the stresses at any point. Without a direct comparison of Professor Unwin's determination with that of Mr. Atcherly no statement can be made as to the relative merits of the two methods. It is believed, however, that Mr. Atcherly assumes a very different distribution of the shearing stress from that shown by Professor Unwin to exist, and upon this distribution the whole computation is necessarily based.

The horizontal section considered by Professor Union is specifically stated by him not to be the base of the dam. Theoretically, the stresses would be greatest on the base of the dam, and it is this section which is chiefly considered in designing dams. But at the base there is a sudden discontinuity of form, such that renders the problem of exactly determining the stresses there beyond the power of mathematics. The effect of the rock into which the dam is built must be to reduce the variation of stress which would otherwise exist. For the engineer's purpose the calculated stresses will be in excess of the real stresses.

This discussion by Professor Unwin may well be permitted to offset that of Messrs. Atcherly and Pearson, at least until both methods have been submitted to experimental investigation, and there is little doubt that the result of the discussion will be the reopening of the whole subject in a manner which will enable the theory of dams to be placed upon a sounder working basis than has hitherto been the case.

One result of the discussion would appear to be a demonstration of the desirability of replacing simple masonry construction for dams by some system better adapted to the conditions which have to be met. There is little doubt that the methods of reinforced concrete, providing for tension stresses in a scientific and rational manner, permit the construction of arches, dams, and other structures far more cheaply, and more satisfactorily than the older methods of pure masonry. In view of the fact that a system containing within itself the ability to resist tension, as well as compression and shearing, is available everywhere, at lower cost than the older imperfect method, it would seem that the better plan would be, not to try to discover how defective the older system is, but rather to emphasise the importance of using the modern system wherever possible. It is more than probable that the present discussion will assume an importance merely academic, after it has well done its work by showing how pure masonry should be abandoned altogether, and by convincing engineers and builders everywhere of the fact that reinforced concrete should become the standard method of construction for important structures of this character.

SPACE CONTROL OF MECHANISM.

METHODS OF APPLYING THE PRINCIPLES OF SPACE TELEGRAPHY TO THE CONTROL OF MECHANISM AT A DISTANCE.

Edouard Branly—Comptes Rendus de l'Académie des Sciences.

UP to the present time the practical applications of the transmission of energy have been developed almost entirely with a view of enabling telegraphic communication to be effected across space without the use of a metallic conductor, and the various systems of space telegraphy have attracted much attention. In a paper recently presented before the French Academy by M. Edouard Branly, himself well known as the inventor of the coherer, some additional applications of the principle are discussed, and from the account of his experiments in a recent issue of the *Comptes Rendus* some of his results are here given.

As. M. Branly remarks, the application of the inductive effects of electric discharges to the transmission of intelligence is the simplest use of the phenomenon, since this involves merely a repetition of the ame movement, the attraction of an electro-magnet, at such time intervals as will permit the distinction of signals. He has therefore attempted to devise an apparatus by means of which a series of events in a pre-arranged system may be effected, the order of action being under control of the distant operator, without requiring the presence of any operator at the receiving station. This idea permits the arrangement of an apparatus for controlling operative mechanisms upon abandoned fortifications, floating hulks, unmanned outposts, and similar situations.

The apparatus which M. Branly has constructed for experimental purposes in his laboratory is arranged to produce three different effects, the starting and stopping of an electric motor, the turning on and off of a system of incandescent lamps, and the effecting of an explosion, any of these effects being produced in any desired order by the distant operator without requiring any metallic or other connection with the receiving station where the motor, lamps, and mine are situated. These especial actions have been chosen arbitrarily for the purpose of demonstration, but it is obvious that a device which can control a group of such effects may readily be adapted to other purposes.

The principal feature which characterizes the apparatus of M. Branly is the construction of what he terms the distributor, by means of which the action of the distant discharge is localized at the receiving station. This distributor, in the case of the experimental apparatus constructed by M. Branly, consists of an insulated axis, carrying metallic discs in contact with brushes and springs for maintaining the passage of an electric current. The axis is maintained in rotation by clockwork, and each disc corresponds to a special function which is to be started and stopped.

Taking, as an example, the disc by which the control of the incandescent lamps is effected, this is arranged with a brush in continual contact with one of its sides. About one-fourth of the perimeter of the disc is of greater radius than the remainder, so that, as it rotates, this portion only comes into contact with a spring. When this contact is made a circuit is completed with a relay which turns on the lamps, but this completion of the starting circuit can be effected only when the coherer forming a portion of the relay is affected by waves emitted from the starting station.

The other discs are similarly arranged to operate their respective circuits, the several discs being so placed on the axis that but one of them makes its spring contact at any one time.

In order that the operator at the transmitting station may be able to determine the control there is arranged a separate transmitter from the receiving station, which marks off on a moving tape before the operator's eyes lines corresponding to the contacts of the respective discs. It is therefore only necessary for the operator to cause a discharge when the proper contact appears before him on the tape in order to cause the lamps, the motor, or the mine to be operated. Thus, the interval between signals 1 and 2 marks the period when a spark from the transmitter will turn on the distant lamps, while the interval between signals 2 and 3 marks the period for starting or stopping the motor, and the interval between 3 and 1 shows the time for exploding the mine.

The various details have been carefully worked out by M. Branly, using his tripod-disc coherer, and employing special protective devices for the prevention of interference between the various discharges. As a piece of laboratory apparatus the arrangement has shown itself to be entirely practical, and there is no good reason why its action may not be extended to distances equal to those over which messages have been sent by the methods of magnetic wave space-telegraphy.

FREIGHT LOCOMOTIVE PERFORMANCE.

DATA AND RESULTS OF TRIALS OF A STANDARD FREIGHT LOCOMOTIVE ON THE ST. LOUIS TESTING PLANT.

Pennsylvania Railroad Company—Bulletin of Tests.

A LOCOMOTIVE is considered primarily as a machine for hauling trains, and many features in its design must necessarily be subordinated to its performance upon the road. At the same time the general principles of steam engine must apply to a locomotive as well as to a stationary engine, and hence it is of interest to compare the performance of a standard locomotive engine with other engines which are operated under more favorable circumstances. Until the use of stationary testing plants for locomotives became possible the comparison of locomotives and stationary engines was difficult, the conditions of road tests being such as to give results which were scarcely comparable with those obtained with machinery at rest. The development of the modern locomotive testing plant, from its small beginnings in Russia and at Purdue University, has now resulted in the systematic testing work conducted by the Pennsylvania Railroad Company upon the plant erected at the St. Louis exposition, and intended for continual service hereafter, and there is no good reason why any of the elements which go to make up the efficient performance of a steam locomotive should not be fully and accurately investigated.

In the bulletin recently issued by the Pennsylvania Railroad Company data and results are given of tests of a standard freight locomotive of the design known in the United States as the consolidation type, or in the international nomenclature as the 2-8-0 type, being the standard heavy locomotive used for freight service on the Pennsylvania system. This engine was of about 1,000 maximum indicated horse power, and was tested at speeds corresponding to about 7 to 25 miles an hour.

The detailed dimensions of the engine are given very fully in the report, but for purposes of discussion it will be of interest to give some of the principal data. Thus, the total heating surface of the boiler was 2,843 square feet, of which 166.4 square feet were in the fire box, and the grate surface was 49.2 square feet, giving a ratio of grate to heating surface of about 50 to 1, the boiler being designed to operate at a pressure of 205 pounds per square inch The steam cylinders were 22 inches diameter by 28 inch stroke.

In the report of the trials the results are very fully tabulated, and diagrams are plotted giving a graphical view of the results as curves, and from these some general conclusions of interest may be drawn.

The method of conducting a test, as outlined in the report, was such as to give confidence in the general reliability of the results, so that they may be considered as fairly comparable with test of stationary engines on record.

"Before the tests were begun, considerable time was spent in making analyses of coal in order to get a bituminous fuel having high fixed carbon, little ash, producing little smoke, and with as little tendency to clinker as possible. That finally accepted was furnished free of charge by the Berwind-White Coal Mining Company, from their Scalp Level mines near Johnstown, Pa. The coal was of very good quality but friable, and when the draft was strong a good deal of the fine portion was drawn through the tubes into the smoke-box. The heating value per pound of dry coal averaged more than 14,000 British thermal units.

"In preparation for a test, the locomotive was gradually worked up to the desired conditions and then run 10 or 15 minutes longer before observations for the recorded data were made. A warning signal of four bells was given five minutes before the test began, and 15 seconds before each reading a signal of two bells was sounded, one bell being sounded for the time of observation.

"Up to the time of starting, the coal and water used were taken from unweighed supplies. At the signal to start a box of weighed coal was dumped on the firing platform. The heights of water in the boiler and the feed water tank were then noted and thereafter all coal and water was carefully weighed. At the conclusion of the test the water levels were brought to the heights noted at the beginning of the test.

"After the last observation the log sheets were worked up by the observers and checked after which they were handed to the computers. As the readings were taken, the principal items were plotted on a graphical running log. Any irregularities or inconsistencies were hence immediately made known."

Considering first the boiler, the most noteworthy feature is the intensity of furnace action. The dry coal fired per square foot of grate area ranged from 22.7 pounds to 86.4 pounds, the firing reaching as high as 4,252 pounds per hour. The equivalent evaporation, from and at 212 degrees, ranged from 262 to 625 pounds of water per square foot of grate per hour, the maximum boiler horse power, computed on a basis of 34.5 pounds, being 891.3 h. p., this evaporation corresponding to 5.18 to 2.39 pounds per square foot of heating surface. The evaporative performance of the boiler naturally varied according to the rate at which it was forced, the evaporation ranging from 11.53 to 6.63 pounds of water per pound of dry coal. The former rate compares very favorably with carefully fired stationary boilers, while the latter is more nearly what has been considered the working performance of locomotive boilers. The efficiency of the boiler dropped off rapidly as the rate of evaporation increased, the range being between the rather wide limits of 78.93 per cent. and 45.37 per cent.

The performance of the engine naturally varied with the operative conditions. The speeds during the tests ranged from 40 to 160 revolutions per minute, corresponding to 6.7 to 26.6 miles per hour, with boiler pressures at about 200 pounds per square inch, and cut off from 22 per cent. for the slow speed to 42 per cent. for the maximum speed. The indicated power at the slow speed was 365 h. p. with a mean effective pressure of 85.7 pounds, and a consumption of 28.33 pounds of steam per i. h. p., the maximum indicated power being 1036 h. p. with a consumption of 23.74 pounds per i. h. p. The maximum dynamometer horse power, corresponding to the above maximum indicated power, was 848.6 h. p., this giving a mechanical efficiency of 82 per cent. for the machine, an excellent showing.

From the viewpoint of the railroad engineer one of the most important points in the performance of a locomotive is the pull on the draw-bar, since this, taken in connection with the effective horse power, determines the usefulness of the machine for hauling cars. The maximum recorded draw-bar pull during these tests was 22,078 pounds, taken at a speed of 80 revolutions, and a cut-off of 37 per cent., corresponding to a speed of 13.4 miles an hour, but higher results might have been obtained had not operative difficulties with the brakes prevented.

Broadly, the result of these tests is to give the locomotive a higher status as an efficient steam engine than it has hitherto held. The conditions which limit the grate area of the locomotive boiler in proportion to the amount of fuel to be burned, and the consequent intensity of combustion, have never appeared favorable to high boiler efficiency, while the absence of independent cut-off gear, and the limitations of the link motion as a regulator of the expansion ratio have also been held unfavorable to best engine performance. Under these structural disadvantages, however, we have results which compare most favorably, both as to boiler and engine, with stationary engines of similar size and speed operating under favorable conditions.

One of the arguments in favor of the application of electric driving to main-line traction has been the superior efficiency of the steam engines and boilers which it is possible to place in the stationary power house over that of the steam locomotive, but when conversion and transmission losses are taken into account it appears that there would be little or no gain in the cost of power at the draw-bar with such locomotive efficiencies as these tests show.

It is only by such exhaustive and scientific investigations that any reliable criterion of performance can be had, and there is little doubt that further tests of locomotives will go far toward furnishing data upon which some of the important questions concerning railway motive power are to be decided.

RAILWAY CAR CONSTRUCTION.

SCIENTIFIC PRINCIPLES APPLIED TO THE DESIGN AND CONSTRUCTION OF THE FRAMING OF PASSENGER AND FREIGHT CARS.

C. A. Seley—Purdue University.

IT is now generally recognized that the effective train-mile capacity of a transportation system, upon which the most advantageous ton-mile rates can be made, depends largely upon the carrying capacity of the cars. For this reason everything which leads to better car construction is of importance both to the railroad man and to the shipper, as tending to higher efficiency in transport.

In a paper recently read at Purdue University by Mr. C. A. Seley, mechanical engineer of the Chicago, Rock Island & Pacific Railway, upon the subject of the framing of passenger and freight cars, some excellent suggestions are brought out in connection with the increase in efficiency of this important element in the mechanism of transportation, and some of the more important points in this paper are here reviewed.

After briefly reviewing the development of the modern car from the early attempts down to modern times, Mr. Seley proceeds to examine especially the development of the modern freight car.

"Our earliest freight cars were 10, 12 and 15 tons capacity and it was not until about 1880 that 20-ton cars were common. Prior to that date the Master Car Builders' Association had been organized and one of their principal aims was to standardize car details so as to facilitate the interchange of cars, that loads could be carried unbroken by connecting lines. The work of that Association has been of the utmost value to the railroads and the public and very many common standards have been adopted, so that wherever a car may stray, the essential parts which have to be maintained in service can be applied without having to send to the owning road for repair parts as was the custom in the early days.

"This standardizing has been of great influence in shaping the designs of the later cars of higher capacity. The last ten years have been remarkable in the history of freight car development. Cars of 40 tons capacity were soon followed by those of 50 tons, and while the latter capacity has been exceeded in a few cases and for special purposes the 50-ton car seems to us to be about the limit. There are two principal reasons for this. One is the concentrated weight on the adjacent trucks of two 50-ton cars coupled being as great as a very heavy engine load. Freight cars are generally allowed ten per cent. excess lading over their marked capacity, and this amounts on a 50-ton car to a total of 110,000 pounds. Adding 40,000 pounds for the dead weight makes a total of 150,000 pounds. There are many consolidation engines that do not exceed the above weight on their eight drivers, yet the common cast iron wheels used under these cars carry as much weight as many an engine driver, and when concentrated on a short span give an equally heavy load. The second reason is that cast iron wheels seem to have about reached their safe limit of their strength in carrying 50-ton cars.

"The vital point in the cast iron wheel is the flange. We cannot thicken it or add supports on account of being restricted by necessary clearance in frogs and crossings. The braking power of 50-ton cars is high and on long grades the wheels become highly heated and then cooled perhaps suddenly. The consequent expansions and contractions may develop fine cracks at the root of the flange and in time weaken the flange. These cracks close and are almost invisible when the wheels are cold and thus escape detection. They are very much in evidence, however, when a piece of the flange drops off in going through a frog or on a heavy curve. This development has caused much concern to the railways and as much as anything else has stopped a further increase in capacity of general service cars."

In considering the framing of freight cars as at present constructed, Mr. Seley calls attention to the fact that the principal elements in the carrying strength are the truss rods by which the sills are reinforced. These are often unsuitably proportioned and spaced. and much better results would be obtained if the distribution of the forces was analyzed mathematically. It is possible however, to take advantage of some hitherto neglected features in freight-car construction and obtain what should be a better and stronger design without materially increasing cost or weight.

"Let us examine the side framing of an ordinary box or furniture car. Beginning at the bolster ends which are the foundations or abutments we find the foot of a diagonal brace which extends outward to support the end of the car. There is also the foot of a vertical post and a framing rod, and then the foot of another diagonal brace inclined towards the center of the car, meeting a vertical post at the plate. We will probably find two or three such diagonal braces and intermediate posts between the bolster and the door posts, and it would seem as though we have all of the elements of a Burr 5-panel truss, the plate and sill being the top and bottom chords and the posts and braces being the vertical and diagonal ties. Now, if such trusses are commonly used in bridge construction and without a set of under trussing, why should the strength of such a construction be entirely neglected and the load carrying be put entirely on the lower framing in car construction? If you will look up your books on such trusses you will note in the diagrams the use of a pair of diagonals in the center panel. In a box car we require the center panel to be left clear for a doorway, but your books go on to state that if the lading is symmetrical the center diagonals have no load and could be omitted. The ordinary lading of cars, when to full capacity, is generally symmetrical or so nearly so that we can afford to neglect the center diagonals and trust to sills and plates taking cars of what little shear there may be from an occasional unsymmetrical load."

The question of all-steel cars naturally suggests itself in this connection, and since the introduction in 1897 of large-capacity steel cars for carrying coal and ore these have been much discussed. The 50-ton self-clearing hopper cars used for carrying coal and iron ore have come into extensive use because of the high percentage of revenue load carried by them. What is meant by the percentage of revenue load may be illustrated as follows: Wooden cars of 44,000 lbs. capacity average about 22,000 lbs. dead weight, a total of 66,000 lbs., of which 66 per cent. is revenue load. Fifty-ton cars carrying 11,000 lbs., weighing 38,000 lbs., carry over 74 per cent revenue load. In the former case, there are 2 lbs. of live load to one of dead, and with the fifty-ton car nearly 3 to 1. A comparison shows that 2½ times the load is carried with but 1.75 times the dead weight.

These advantages, however, appear only when the cars are run fully loaded, and this condition cannot always be fulfilled. Experience has shown that for general purposes the limiting useful capacity of box cars is about 40 tons.

Mr. Seley goes into the application of the truss system to cars somewhat in detail, especially as connected with the use of steel side framing, and the fact that more than 10,000 cars have been built on this principle and operated with satisfactory results is a strong verification of the correctness of the method.

The importance of directing the best engineering ability available to the question of car construction will be emphasised when it is realised that the cost of the freight-car equipment of a railroad ranges between three and four times that of the locomotives, and Mr. Seley's paper itself forms an important argument for the value of the application of scientific principles to this department of railway engineering.

HIGH-SPEED RAILWAY TRAINS.

A COMPARATIVE STUDY OF THE FASTEST REGULAR TRAINS ON EUROPEAN AND AMERICAN RAILWAYS.

Arnold Kramer—Glasers Annalen.

IT is not easy to compare the performance of high-speed trains in different countries, or even in different parts of the same country, simply because the question contains too many variables. The character and weight of train, the grades and curves of the roads, the nature of crossings and systems of signalling, and numerous operative details enter into the problem of train speed, and in the desire to make a good showing for their roads the respective advocates find ample opportunity for arrangement of the reports and records to support their contentions. It is, therefore, interesting to note a paper in a recent issue of *Glasers Annalen* by Mr. Arnold Kramer in which a comparison of a number of high-speed trains is made based entirely upon the running schedules, and freed from any attempt to advocate the performance of any particular road, the facts being considered entirely from an outside viewpoint.

Leaving out of consideration the speeds made upon the Marienfelde-Zossen railroad as experimental, and taking the data from the operative schedules for 1903, Mr. Kramer gives some interesting comparative figures. Germany does not appear at all in the comparison, and Mr. Kramer explains that this is due both to the fact that the lighter permanent way of the German railways does not permit the safe attainment of maximum speeds, and also because the increased cost of high speeds does not appeal to the management. It may be remembered that the first experiments on the Marienfelde-Zossen line showed that the limits of speed were due to the condition of the track, and that the highest speeds were not attained until the entire line had been re-laid with much heavier rails than had been originally thought necessary.

The fastest train in Europe is operated by the Northern Railway of France, on the line between Paris and Calais, the train being drawn by a De Glehn four-cylinder compound locomotive, a photograph of this train being shown on page 968 of the September issue of this Magazine for 1904 The distance between Paris and Calais is 184.73 miles, and this is covered by the express trains in 3 hours and 1 minute, including a stop of 4 minutes at Amiens for water. The run from Paris to Amiens is made at a speed of 63.2 miles per hour, and from Amiens to Calais at 59.7 miles per hour. It is intended to place track tanks on this line to enable water to be taken up while running, and this will enable the stop at Amiens to be avoided.

Mr. Kramer admits that the fastest train in the world in regular service is the Atlantic City Flyer of the Philadelphia and Reading Railway, this train making the run of 55.5 miles between Camden and Atlantic City at a rate of 67.96 miles per hour. This train is closely pressed by the Pennsylvania Railroad between the same points, its distance of 58 miles being made at the rate of 66.92 miles per hour The weights of the trains average about 200 tons, and upon special occasions the Reading trains have made the distance of 55.5 miles in 46.5 minutes, corresponding to a speed of 71.6 miles per hour, while a portion of 35 miles of the run has been made at the rate of 81.5 miles per hour.

The fastest train in the world for a distance of more than 300 miles is the Empire State Express of the New York Central and Hudson River Railroad, this making the distance of 439.52 miles from New York to Buffalo in 8 hours and 15 minutes, a speed of 53.3 miles per hour. This is closely followed by some of the long-distance trains in Great Britain, the distance of 393 miles from London to Edinburgh, by way of the Great Northern Railway, being made in 8 hours 15 minutes, a rate of 53.3 miles per hour, while the 401 miles from Euston to Glasgow, by the London and Northwestern Railway, is covered in 8 hours, a speed of 50.1 miles per hour.

Returning to the Continent, we have the Sud-Express of the Paris, Lyons and Mediterranean Railway, making the run of 486.25 miles from Paris to Bayonne in 9 hours 43 minutes, a speed of 50 miles per hour, while it is proposed to operate on the same line a through train from Paris to Nice, a distance of 674.4 miles, in 13 hours 30 minutes, this giving also a speed of 50 miles per hour, maintained for a longer run than has been attempted anywhere.

Mr. Kramer tabulates a number of the high-speed trains of Great Britain and the United States, for which reference must be made to his original paper, but some general deductions may be made from the tables. Thus in England the average speeds on runs of 50 to 200 miles in length ranges from 55 to 61.7 miles per hour, the most notable of these being the run from Paddington to Exeter, on the Great Western Railway, 193 miles at 55.3 miles per hour. About 55 miles per hour appears to be the running speed of a number of British express trains.

In the United States the rate naturally falls off for the longer distances and as the first-class road-beds of the great trunk roads are passed. The Twentieth Century Limited, of the New York Central, makes the run from New York to Chicago, a distance of 979.5 miles, at a rate of 49 miles per hour. From Chicago to San Francisco, a distance of 2,314.90 miles, by way of the Chicago and Northwestern Railroad and the Union Pacific Railroad, an average speed of 33.58 miles per hour is made, including 44 stops, while by the Santa Fé route, a distance of 2,569 miles, the average speed is 33.75 miles per hour. It must be remembered that these are average speeds over much difficult country, involving heavy grades and many curves, and that much higher local speeds must be made over long stretches in order to maintain this average for the entire distance between Chicago and San Francisco.

As Mr. Kramer states, there is a constant and gradual tendency to increase and maintain higher speeds, and with the improvements in permanent way, the introduction of balanced compound locomotives, and the increase in traffic, the standard of speed may be expected to advance. It is too soon to predict the effect of the introduction of electric traction upon main-line speeds, but the trials of the electric locomotives which have been made for the New York Central system show that if higher speeds are demanded they can be furnished as well by electricity as by independent steam locomotives.

With all this striving for increased speeds in railway travel it must not be forgotten that it is actual economy in time between terminals which really counts, rather than spurts of greater or less duration upon the route. It is of small value to gain a few minutes on the road, to waste several times the gain while waiting in the terminal yard or standing in a ferry slip, and that road which gives the highest speed service to its patrons is the one which carries them in the shortest time from platform to platform of its terminals, and not the one which can only point with pride to a record run for a portion of the distance. That this fact is appreciated is shown by the great expenses which are being incurred in the large terminal cities to avoid grade crossings and other occasions for slowing down in approaches, and there is at present much greater opportunity for gaining time by just such radical work than is apparent by forcing higher train speeds upon the road.

STEAM-TURBINE CONSTRUCTION.

PRACTICAL EXPERIENCE WITH THE MECHANICAL CONSTRUCTION OF STEAM TURBINES AND TURBO-GENERATORS.

W. J. A. London—Institution of Electrical Engineers.

NOTWITHSTANDING the attention which has been given to steam-turbine design from the thermodynamic standpoint, there has been little published relating to the mechanical features which are necessarily involved in the building of machines differing so widely in form and operation from the ordinary steam engine. For this reason the paper of Mr. W. J. A. London, presented before the Manchester section of the Institution of Electrical Engineers is of interest, dealing as it does with structural details, not only of the steam turbine, but also of the special forms of electrical generators adapted for direct-connection to motors of such high rotative speeds.

Speaking first of the features of the horizontal and the vertical designs of steam turbines, Mr. London says:

"Steam turbines are now constructed with vertical and horizontal shafts. The vertical turbine naturally appeals to the engineer at first sight as being the most suitable for high speed, there being no sagging in the shaft (due to its own weight between the bearings). The further claim is made for the vertical engine that it takes up less floor space than does the horizontal design, this saving meaning a lower cost of foundations and smaller engine room. The present designs of the vertical turbine, however, now on the market do not differ to any great extent in superficial floor area from that taken by one or two types of horizontal machines. Against the advantages set forth above of the vertical machine we must put the following disadvantages:—General inaccessibility, and the difficulty met with and time necessary for the withdrawing of, say, the turbine spindle to attend to any repairs that may be necessary. The footstep bearing necessary to support such a rapidly revolving heavy shaft calls for an exceptional design, and should the supporting fluid give out, considerable damage would be done. Auxiliary machinery is necessary for the supply of this supporting fluid, and also a relay connected to an emergency pump. This auxiliary machinery means additional plant to look after, and floor space which must be added to that taken up by the turbine. A further disadvantage of the vertical type is the fact that the heat radiated from the turbine cylinder rises up and heats the generator. The top bearing must be so designed that it is not possible for any oil to leak on to the generator, the effect of this being often very serious. The stuffing box between the turbine and the generator must also be absolutely steam tight, to prevent the possibility of any vapour rising into the generator. None of the above difficulties are met with when the machine is built on a horizontal axis."

Mr. London passes in rapid review the different forms of steam turbine, showing how the machines of the pure impulse type, in which the expansion practically all takes place in the stationary members present different structural problems from those obtaining in the so-called pressure turbines, in which the expansion occurs in the revolving as well as in the stationary blades. In the impulse machines, such as the De Laval, Rateau, Zoelly, Curtis, etc., there is little or no difference in pressure between the two sides of the wheel, so that there is no great tendency for the steam to leak past the periphery of the wheel and in consequence fine radial clearances between the wheel and the casing are not needed. In such machines, even of the multiple type, the distance between shaft bearings is comparatively short, and possible troubles from bending or whipping are correspondingly reduced.

In the Parsons and Westinghouse turbines a totally different general construction from that of the impulse machine is required. A spindle of a Parsons turbine consists usually of a cast-steel drum having forged steel ends shrunk or pressed into it. This form of spindle is much stiffer than a thorough-going shaft with disks, but a certain amount of whipping may take place, owing to its overall length.

"With the Rateau, Zoelly, or Curtis machines, the steam can be concentrated and passed through only a portion of the periphery; but in consequence of the difference of pressure existing between the two sides of the rotating vanes in a Parsons turbine, the whole annulus must be filled with steam, so that small diameters and low velocities have to be resorted to where its density is very high, in order that the percentage of clearance to blade height may not be excessive. As the steam expands, its volume increases, and as the number of rows or blades varies with the square of the velocity, it is advantageous to step up in the diameter of the spindle as soon as possible."

In some of the more recent Westinghouse turbines the machine is made double-flow, steam being admitted in the centre, passing through equal rows of blades on each side, end thrust thus being eliminated. By adopting a combined impulse wheel to take care of the expansion from boiler to about 60 pounds absolute it is found that the velocity required permits such dimensions that the Parsons blading can be successfully used on the one diameter. Such a mixed turbine can be made much shorter than the original Parsons type, while maintaining the same high degree of efficiency.

The high rotative speeds met in steam-turbine work naturally renders the bearings and journals different from those developed in the experience with slow-running steam engines. The demand for stiffness involves the use of shafts and journals of large diameter with bearings of ample length to keep down the unit pressure. Large diameters, however, mean high circumferential speeds, increasing the work of friction, while there are limitations to the effective length of bearings.

"The effect of clearance has a marked influence on the efficient working of turbine bearings. In consequence, it is better to ease the bearings considerably on the upper half; this materially decreases the friction, and allows much smoother running. If the shaft is well balanced, the upper half of the bearing can be entirely dispensed with, and this is practically done in many instances, a clearance of 1/16 in. being allowed on the top half of the bearings. However, instead of cutting the whole of the top of the bearing away, it is safer to allow a strip of the bearing to remain along the top, thus holding the whole shaft.

"The peripheral velocity in turbine bearings is necessarily very considerably higher than in ordinary steam engine practice, velocities of 50 ft. per second being regular practice. The load per square inch, however, must be kept very low. In steam turbine practice to-day it is usual to allow a constant of 2,500 for the peripheral velocity in feet per second multiplied by the pressure per square inch on the bearings. This in some cases is raised as high as 3,000. The crux of the whole question is the facility for dissipating the heat, and for this reason as much of the bearings as possible should be in contact with the outer walls, provided, of course, that the outer walls themselves are also free to dissipate heat. Water-cooled bearings are very often resorted to in very large machines, the principal advantage of these being that in a turbine of the Parsons type the water-cooled bearing isolates the heat of the high pressure end of the turbine from the bearing proper. In machines where there is no close contact with steam-heated surfaces, bearings working within the limits mentioned can be run satisfactorily without water cooling. An ample oil supply, however, should be given. The oil leaves the bearings uncontaminated by water or other matter, and can be returned to the cistern and re-used. The usual European practice in turbine work is to allow about .05 gallon per square inch of bearing surface per minute."

The high rotative speeds of steam turbines has naturally demanded corresponding modifications in dynamo construction. Both for continuous and for alternating current machines the centrifugal forces demand modification in construction. The majority of continuous current machines are constructed wth semi-enclosed slots, a key-piece being driven in on top of the conductors to hold them in position. Bronze end bells have been employed to hold the end windings, but even this material must be employed with care to secure sufficient strength.

The larger alternators are made with rotating fields and stationary armatures, and in such designs it has been found advisable to make the rotors of solid steel forgings, the centre being bored out to admit the high-carbon steel shaft, the sides being milled out to admit the windings, ventilating ducts being also milled out.

"As in continuous current work, special care must be taken with the winding of the rotors so that the possibility of the shifting of the conductors is reduced to a minimum; and further, owing to the great weight of these rotating fields, the shafts should be as stiff as possible to prevent whipping, which point to another advantage of the solid pole construction, as it materially stiffens the shaft.

"In turbo-alternators, while the core and copper losses are slightly smaller than those of the slow-speed type, it is much more difficult to dissipate the heat on account of the much smaller radiating surface. To reduce as low as possible the loss by windage, smooth cores should be adopted where possible. In order to obtain ventilation two methods may be adopted:—

"1. As much exposed surface and free airway as possible.

"2. Machines entirely enclosed, with forced ventilation.

"Both these systems are now extensively used, and it is hard to decide which is preferable. The first has the advantage of being more efficient, but has the objection of being noisy. This noise is almost entirely eliminated in the enclosed machine, but tests have shown that with this type, to obtain sufficient ventilation, a considerable amount of power is absorbed by the blowers, resulting in a somewhat less efficient machine."

Mr. London discusses the problems involved in balancing, but these are not greatly different from those already experienced in high-speed woodworking machinery, and both in theory and practice they are well understood.

THE STRENGTH OF BOILER FURNACES.

PRINCIPLES OF DESIGN AND CONSTRUCTION OF INTERNALLY-FIRED BOILER FURNACES FOR THE MAINTENANCE OF MAXIMUM EFFICIENCY.

D. B. Morison—North-East Coast Institution of Shipbuilders.

INTERNALLY - FIRED boilers are among the oldest forms which have been used for the generation of steam, and with modern improvements they are still very extensively used, especially in marine service.

In the early Cornish and Lancashire boilers the furnaces, in which the grates are placed, in which the highest temperatures are produced, and from the surfaces of which the greater proportion of the steam is generated, were made in the form of plain cylindrical tubes straight in longitudinal section throughout their length. Such furnaces could be operated only at moderate pressures, owing to the danger of collapse by external pressure, and hence the demand for higher pressures led to various methods of strengthening the weak construction. Since it was early shown that a long tube offered less resistance to collapsing than a short one it was suggested that the addition of circumferential reinforcements to a flue at intervals would effect the result of converting it into a succession of short flues, with corresponding increase in strength, and from this idea may be said to have developed the modern types of corrugated and suspension furnaces in general and successful service.

In a paper presented recently before the North-East Institution of Engineers and Shipbuilders by Mr. D. B. Morison, the development of the modern furnace is discussed and some of the operative conditions affecting its strength are examined in a very practical manner.

"The strength value of a furnace can be estimated only by its behaviour when in use in a boiler under severe conditions of work. If the wall of a furnace were always clean and a good conductor of heat, so that the temperature of the metal never largely exceeded the temperature of the boiler steam, then the furnace would never deform, because in that condition it would be capable of withstanding (according to Board of Trade regulations) about five times the load which could ever be imposed upon it by the steam pressure

Therefore, a furnace deforms or collapses only when a portion of its wall becomes so overheated as to reduce the strength of the metal by an amount which renders it incapable of resisting the pressure to which it is subjected, and it follows that the safety of a furnace does not depend so much upon the strength theoretically derivable from any particular form of tube, as upon the ability of that form to minimise the possibility of local overheating, and to safely withstand the weakening effect of overheating, should it by any chance occur. It is consequently possible for a tube to be of great strength when subjected to cold water external pressure, and yet be practically a failure as a furnace in a boiler."

The early methods of reinforcing furnaces by the use of stiffening rings and the like were effective in eliminating the longitudinal weakness, but they introduced new difficulties which had in turn to be met.

"Deformation involves definite mechanical movement, and this, of course, cannot take place at any point without either fracturing, extending, or compressing the metal in the immediate vicinity, and it is the resistance of the adjacent material to this fracture, extension, or compression that reinforces the material at the point where the localised stress has become most severe. If a cylinder be provided with stiffening rings, it is evident that these rings will not be deformed under a stress which is quite sufficient to collapse the intervening metal, so that they constitute fixed points of support, between which deformation of the cylindrical form can only take place by the extension of the metal. No deformation can take place between the stiffening rings which does not impose a bending stress upon some portion of the intervening metal, and the shorter the distance between these points of support, the stronger will be the longitudinal section, considered as a beam."

It soon became evident that the reinforcement, to be free from disturbing influences, should be formed in the material of the furnace, and Mr. Morison traces the development of such improved furnaces, from the strengthening rings of the Purves furnace, through the great improvement of the Fox corrugated furnace, to the suspension type of furnace, in its earlier and later improved forms. The term "suspension" as applied to furnaces of this class is shown to describe the action correctly, since the ridges, being the stiffer and cooler portions, act to sustain the valleys. The strength-controlling elements of the structure are the ridges, and until they yield the furnace cannot collapse.

"A furnace is often very severely strained and is liable to slight deformation if the tubes are too close to the crown or if the furnace is otherwise too rigidly stayed. A furnace is subjected to very great variations of temperature, and is consequently always tending to lengthen or shorten, so that, if by faulty design it is not allowed breathing facilities, it will either leak at the landings or alter its shape. Furnace firebars should not be fitted in tightly when cold, for obvious reasons. Assuming that attention is given to these points, and that shortness of water does not occur, a furnace collapses only when its wall becomes heated to redness through either oily deposit or excessive scale, so that the safest furnace is the one which will longest withstand the conditions of severe usage before the metal in any portion of its wall becomes weakened through overheating, and which having become overheated will retain its shape for the longest period of time before collapsing. If a furnace of any recognised type is covered with water and is reasonably clean, it will never collapse, as in that condition its resistance is five times greater than the load brought upon it by the steam pressure, but this margin commences to disappear when the temperature of the metal reaches 650° F., and vanishes when the metal becomes red hot."

Since furnaces are readily made of ample strength to resist ordinary working stresses it is evident that the real capacity of a furnace to resist collapse becomes apparent only when it is exposed to extreme heat. As we have said temperature at which steel begins to lose its strength appreciably is about 650° F., and at 1,200° F. about 75 per cent. of the strength has disappeared. The lower of these temperatures is never reached by steam at any working pressure, since the temperature of steam at 200 pounds pressure is only about 380° F., hence all that is necessary is to keep the surfaces clean in order to avoid overheating.

It is not necessary that a thick deposit of oily matter should form upon the furnace to cause the temperature to rise, since a mere coating of oil, of inappreciable thickness, is sufficient to check the protective action of the water and permit the temperature of the metal to rise about the weakening point. Mr. Morison cites an example in which the use of an inferior quality of oil for swabbing the engine rods and for lubricating the auxiliary engines caused a serious collapse. The oil, becoming emulsified with the feed water, and being therefore unfilterable, passed into the boilers forming a deposit on the furnaces.

"When oil is fed into a cylinder, it should not only be unaffected by the temperature, but should distribute itself amongst the steam in such a manner as to effectively lubricate the surfaces with which it comes in contact. If, on the other hand, the oil is so sluggish as not to associate with the steam, it is either local in its action, or it is blown through the engine practically unused. Cylinder oil should therefore possess the greatest fluidity consistent with the conditions and requirements prevailing, and yet have sufficient viscosity to perform its lubricating functions on the parts to which it attaches itself and which, in the case of cylinders, are always more or less wet. In order to increase the lubricity of pure mineral oil, and to assist it to adhere to the cylinder surfaces, some manufacturers add a very small percentage of saponifying oils; but for very high temperatures, and especially for superheated steam, it is very questionable whether a straight high-grade oil is not the safer to adopt. Other essentials for a good cylinder oil are that it shall not carbonise or gum, and that it shall be entirely free from acid. The demands are most exacting, and can only be met by a mineral oil of the highest grade.

"Steam from auxiliary engines, steering engines, winches, or other deck machinery, should not be discharged into a main condenser direct, but into an auxiliary condenser, and then only after the oil has been separated from it. Such precautions, as I have indicated, constitute a necessary standard of engineering practice, if maximum commercial success is to be attained, as only by their strict observance can the efficiency of the heating surface of the boilers be maintained, and the risk of furnace accidents reduced to a minimum."

THE EFFICIENCY OF GAS ENGINES.

A SYMPOSIUM UPON THE MECHANICAL EFFICIENCY AND THE INDICATED CAPACITY OF INTERNAL COMBUSTION MOTORS.

Zeitschrift des Vereines Deutscher Ingenieure.

IN the course of investigations intended to aid in the establishment of standard methods of rating the performance of internal-combustion motors, the Verein Deutscher Ingenieure has recently published in its *Zeitschrift* a symposium of communications from a number of eminent engineers of experience in this line of work. Among the contributors to this valuable discussion we note the names of such men as Stodola, Riedler, Meyer, Schöttler, Ehrhardt, and Wagener, and the points brought out are of value and interest.

Professor Stodola points out that our notions of gross and net efficiency in gas engines are derived from similar terms in connection with steam engine practice, the net power being simply the gross indicated power less the frictional losses in the machine, and the mechanical efficiency being the ratio of the net to the gross power. He also refers to the so-called thermodynamic efficiency, this being the ratio of the work developed to that which would be obtained from the same quantity of heat supplied to an ideal machine working through a predetermined cycle. The ordinary idea of the thermal efficiency of a heat engine of any type is the ratio of the heat equivalent of the work developed to the total amount of heat supplied in the fuel.

In the practical application of these values, however, various opportunities for differences in opinion and practice occur. Thus, in the case of the steam engine there are other losses besides the friction of the mechanical parts, and among these Professor Stodola calls attention to the loss by throttling the exhaust, and to the leakage losses. In the case of the condensing steam engine the question also arises as to the deduction of the resistance, frictional and otherwise, of the air-pump, especially when this is driven independently, either by steam or electricity. In the case of the two-cycle gas engine there is also the resistance of the compression pump to be taken into account, and comparable results cannot be expected unless these points are consistently treated. It is a question whether the actual resistance in the compression pump should not be separated from its frictional resistance, and Professor Stodola maintains that the air pump should be indicated as well as the working cylinder, and that the difference between the power indicated in the cylinder and the resistance indicated in the air pump be taken as the true indicated power. In this position he is supported by the precedent of Professor Schröter in his tests of the Diesel motor, and by Mr. Dugald Clerk in his practice.

This point is of especial importance in the determination of the mechanical efficiency of the gas engine, since the ratio of the indicated power to the brake power will be very materially affected according as the indicated negative work on the air-pump is deducted or not.

Professor Riedler maintains that the indicated efficiency of a gas engine should be based upon the indicated power in the cylinder, regardless of the work to be overcome in the compression pump, and cites the similar practice in steam engineering, in which no deduction is made for air-pump resistance, the resistance of the air-pump being wholly included with the mechanical resistance of the engine. Professor Meyer differs in this respect, but very properly considers it a matter of minor importance, since the thermal efficiency of the gas engine should be based upon the brake horse power, as the only true measure of efficiency.

Professor Riedler calls attention to the fact that the resistance of a compression pump operating in connection with an internal-combustion motor is by no means analogous to that of an air-pump working in connection with a steam engine, the latter acting to reduce the back pressure in the power cylinder, while the former does not.

So far as the actual practice goes, it is a matter not so much for discussion as for unification, and it is most desirable that the system of reporting gas-engine tests should be standardized in such a manner as to render the results scientifically and practically comparable. It is of little use to state that such an engine has a thermal efficiency of 30 per cent., for example, if it is not known upon what basis the efficiency is computed, and of two such indefinite statements one cannot tell in any way which is the better machine.

In the codes of the American Society of Mechanical Engineers for testing steam and gas engines, the question of the resistance of the pumps is not stated to be deducted from the indicated power in determining the efficiency, although all the steam consumed by the auxiliaries is directed to be changed to the steam-consumption of the engine, this steam being measured separately, when possible, for convenience in analyzing the performance. In both steam and gas engines the power is stated to be either indicated or brake, but no hint is given as to whether the indicated power is simply the power indicated in the main cylinder, or whether it has had the air pump or compression pump resistance deducted.

As a matter of fact practice is contradictory in this respect. In steam-engine trials it has been customary to take the indicated power as simply that shown by the indicator in the cylinder, and to allow all other resistances to be included in the internal resistances of the engine, and deducted by the operation of measuring the brake horse power. This practice undoubtedly acts to give a higher thermal efficiency and a lower mechanical efficiency than would be the case if the indicated negative work in the pump were deducted from the indicated power before making the computation. In the case of internal-combustion motors it appears to have been the practice to deduct the work done in the compression pump, and Professor Meyer calls attention to the fact that the negative work in the compression pump was deducted in the case of the tests of the Ericsson hot air engines, as well as in the tests of the Brayton petroleum motor and the Diesel motor, these various engines covering practically the entire period of practical work with the internal-combustion motor.

The matter is one of importance, mainly because it is desirable to have the reports of trials in comparable form, and it is probable that with the increasing practice of using engines to drive electrical generators, the efficiency will be determined upon the actual horse power developed, and measured by the electrical output, the use of the indicated power as a basis of efficiency being entirely superseded by the more practical ratio.

RAINFALL AND EVAPORATION.

EVAPORATION OBSERVATIONS IN THE UNITED STATES AND THEIR RELATION TO PRACTICAL IRRIGATION PROBLEMS.

H. H. Kimball—National Irrigation Congress.

IT is an interesting fact that although much attention has been given by engineers to the observation and study of the precipitation of water from the atmosphere, the reverse action, the absorption of water by the air, has been but little studied. Since artificial irrigation becomes necessary principally in dry climates it becomes of much importance to determine what proportion of the water supplied is lost in evaporation, and a paper by Mr. H. H. Kimball discussing this subject before the Twelfth National Irrigation Congress is therefore acceptable as a contribution to a question upon which there is little information available.

"It is important that irrigation engineers should know not only the rainfall, but also the evaporation over any given region. Unfortunately, the measurement of evaporation presents many more difficulties than the measurement of precipitation. In fact, the rate of evaporation from land surfaces depends upon so many different elements that it can be treated only in the most general manner. Thus, it has been shown that the evaporation from saturated soil covered with growing plants is greater than from water surfaces, but becomes less when the level of complete saturation falls a few inches below the soil surface, and continually diminishes as this level recedes to increasing depths. Also, the evaporation from a forest of evergreen trees is greater than from a forest of leafy trees; from the latter it is greater than from grass, from which in turn it is greater than from bare soil. The composition of the soil has its effect upon the rate of evaporation, and so also has the state of cultivation. Furthermore, the rate of evaporation from any surface has been found to vary with its temperature, with the quantity of moisture in the air, and with the wind velocity.

Mr. Kimball tabulates some of the results obtained by Mr. Rafter for the eastern part of the United States, which tend to show that from 20 to 26 per cent. of the rainfall disappears from the run-off, but these results can hardly be considered as applicable to other parts of the country where the atmosphere and the surface of the earth contain a much smaller proportion of moisture, besides which the accuracy of this method of determination can hardly be considered as altogether satisfactory.

"As a practical problem in irrigation, however, the evaporation from water surfaces is of much more importance than the evaporation from land surfaces. The engineer will naturally determine his water supply, not from the annual precipitation, but from the run-off of available streams. Having ascertained this, the question of losses becomes important, and if storage basins are of considerable area the loss by evaporation in a dry climate becomes very serious, having been estimated, in some cases, to be as much as 30 to 50 per cent. of the amount stored.

"Fortunately, the determination of the evaporation from a water surface presents fewer difficulties than the evaporation from land surfaces. Generally speaking, the determination may be made by two quite different methods: by direct measurements from properly exposed water surfaces, and by computations based upon the temperature of the water surface and the value of certain meteorological elements. With proper attention to exposure, direct measurements of evaporation from water surfaces should give the more reliable results. Unfortunately, proper exposure is not always practicable, and it is therefore necessary to consider the character of the exposure in connection with each series of evaporation experiments, and in some cases to apply a correction before the results will fairly represent the evaporations from a reservoir or a lake."

Among experimental investigations of the evaporation of water from exposed surfaces those of Mr. Desmond Fitzgerald are cited as being very complete, both as to the original data and the relations established between them. These experiments were conducted in connection with the reservoirs of the Boston waterworks, and gave data showing the connection between the rate of evaporation, the temperature of the water surface, the humidity of the atmosphere, and the wind. According to these investigations Mr. Fitzgerald established a formula in which the rate of evaporation could be computed from the vapor pressures corresponding to the temperature of the surface of the water and the humidity of the atmosphere, and the wind velocity. A similar formula has been derived by Professor L. G. Carpenter from observations made at Fort Collins, Colorado, and these are of interest because of the very different climatic conditions of the location. Mr. Kimball also examines the formula of Professor Russell, of the Weather Bureau, this being based upon a collation of Weather Bureau observations, and including the barometric pressure among the elements to be considered. With Professor Russell's investigations there is included a map showing lines of equal annual evaporation in inches from a free water surface, which is interesting especially as showing the variations in rate for different parts of the United States.

"Upon the organization of the Irrigation Survey by the U. S. Geological Survey in 1888, arrangements were made for measuring the evaporation at several points in the arid regions of the United States. It was recognized that the rate of evaporation depended upon the dryness of the air, the temperature of the water surface, and the velocity of the wind at the water surface. An effort was therefore made to measure the evaporation from a water surface having the same temperature as the surface of lakes or reservoirs, and exposed to the same wind velocity. To accomplish this galvanized-iron evaporating pans, three feet square and eighteen inches deep, were floated on the surface of the body of water from which the evaporation was to be measured. The pans were kept nearly full, with the surface of the water in them about on a level with the water outside. The evaporation was at first measured by some sort of gage, but later was determined from the amount of water that was added to bring the surface to the top of a pin projecting from the center of the pan. A record of the water temperature inside and outside the pans was kept. Usually a difference was noted, the inside temperature being higher in the daytime and lower at night. The average is, however, about the same in each. It is not probable that the water in pans is exposed to quite so high a wind velocity as the average over outside surfaces, but to offset this the water in the pans wets the sides, and this increases the evaporating surface. It is therefore assumed that in general the evaporation from a floating pan of this type when kept nearly full represents the evaporation from the outside water surface very closely."

Mr. Kimball tabulates the observations of the Geological Survey with computations from Russell's formula, and while the results are fairly comparable the computed evaporations are somewhat higher than the observed values. For practical engineering work the formulas of Fitzgerald and of Carpenter appear to be preferable.

This whole subject is of especial interest in connection both with irrigation and with municipal water supply, and in view of the manner in which observations have been gathered and discussed it appears to be entirely feasible to compute in advance the losses by evaporation with a degree of precision at least as high as many other elements in the whole problem.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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A Few Points in the Design of Reinforced Concrete Arches. B. R. Leffler. Gives some short processes in the graphical analysis of the elastic arch, based on the method given by William Cain, with which the reader is supposed to be familiar. Ills. 1200 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69269 E.

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Erection.

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Pier.

A Large Concrete Pier with a Sheet Pile and Canvas Cofferdam. James C. Hain. States the conditions and gives an illustrated description of work at Kilbourn, Wis. 1200 w. Eng News—March 30, 1905. No. 68833.

Quebec Bridge.

The General Design of the Quebec Bridge. Illustrated detailed description of the structural features of the bridge over the St. Lawrence river, being the longest span yet undertaken. 2200 w. Eng Rec—April 1, 1905: Serial. 1st part. No. 68823.

Reinforced Concrete.

A Reinforced Concrete Foot-Bridge at Como Park, St. Paul, Minn. Illustrated description of bridge and construction. 600 w. Eng News—April 6, 1905. No. 68836.

Testing the Armoured Concrete Bridge at Soissons. Describes the tests made of a bridge of the Hennebique type in France, giving the results. 2500 w. Engr, Lond—March 24, 1905. No. 68757 A.

The Reinforced Concrete Bridge at Kankakee. R. D. Gregg. Detailed description of the construction. 2500 w. Eng Rec—April 1, 1905. No. 68829.

Suspension.

Suspension Bridge across the Rhone at Jons-Niévroz (Pont Suspendu de Jons-Niévroz sur le Rhone). J. Dor. Illustrating a highway suspension bridge of 200 metres clear span across the Rhone above Lyons. 2000 w. 1 plate. Génie Civil—March 18, 1905. No. 69114 D.

Transporter.

The Runcorn Transporter Bridge. Illustrations, with brief description of this aerial ferry. 400 w. Engng—April 7, 1905. No. 68920 A.

Viaduct.

The Cuyahoga Valley Viaduct. G. H. Tinker. Illustrates and describes the design of the new structure at Cleveland, O., stating some of the problems in the erection. 1300 w. R R Gaz—Vol. XXXVIII. No. 15. No. 68941.

Zambesi.

The Victoria Falls Bridge. Illustrated description of the highest bridge in the world in process of erection for the Rhodesian Railway Co. over the Zambesi river, and also describing the natural features of the locality. 2300 w. Engr, Lond—April 7, 1905. No. 68993 A.

The Zambesi Bridge. Editorial on the closing of the two arms of this great steel arched bridge spanning the Zambesi gorge over 400 ft. above water-level. 1300 w. Engng—April 7, 1905. No. 68919 A.

CONSTRUCTION.

Acoustics.

Architectural Acoustics. G. R. Anderson. Considers the problems of construction that relate to the regulation of sound. Discussion. 2500 w. Can Archt—March, 1905. No. 68739 C.

Bins.

The Strength of the Walls of Grain Bins (Calcul des Parois des Silos à Grains). Alexandre Sée. Working out the method for calculating the lateral pressure of grain, and deriving formulas for practical use in constructing bins. 2000 w. Génie Civil—April 8, 1905. No. 69121 D.

Building Construction.

Engineering Features of the New England Conservatory of Music, Boston. Howard S. Knowlton. Illustrates and describes the construction of a building to meet the needs of about 1,500 students in instrumental and vocal music. 2500 w. Eng Rec—April 1, 1905. No. 68827.

Central Stations.

Cement in Central Station Design. Eugene B. Clark. On the use of cement in the building of power-houses, as illustrated in a recently completed plant of the Illinois Steel Company in South Chicago. 4000 w. Am Inst of Elec Engrs—April, 1905. No. 69032 D.

Chimneys.

Tall Chimney Construction. Discusses problems in connection with the design and construction of tall chimneys. Illus. 2800 w. Builder—April 8, 1905. No. 68975 A.

Coal Pocket.

The Building of a Concrete Coal Pocket. John M. Bruce. Illustrates and describes an interesting example of reinforced concrete construction at Bradford, R. I. 1500 w. Cement Age—March, 1905. No. 68730.

Coffer Dams.

Coffer Dams in Reinforced Concrete (Batardeaux en Béton Armé). M. Tricon. Describing especially the use of reinforced concrete for coffer dams in constructing canal locks and similar works. 1800 w. Revue Technique—March 25, 1905. No. 69139 D.

Cost Keeping.

See Industrial Economy.

Dams.

A Hollow Reinforced Concrete Dam at Schuylerville, N. Y. Illustrated detailed description. 2000 w. Eng News—April 27, 1905. No. 69251.

Construction, Repairs and Subsequent Partial Destruction of the Arizona Canal dam, Near Phoenix, Ariz. H. F. Robinson. Illustrated report. 1000 w. Eng News—April 27, 1905. No. 69252.

The Stability of Masonry Dams. A review of the application of the theory of Atcherly and Pearson to the stability of the Assouan dam, showing the importance of considering the vertical stresses. 1800 w. Engng—March 31, 1905. No. 69177 A.

Masonry Dams. An editorial reviewing the paper of Atcherly and Pearson upon disregarded points in the stability of masonry dams, showing the relation of the theory to the Assouan dam. 2000 w. Engr, Lond—March 31, 1905. No. 69178 A.

The Barossa Dam, Southern Australia. Emile Guarini. Illustrations, with brief description, of a curved concrete dam recently finished. 700 w. Sci Am—April 1, 1905. No. 68846.

Domes.

Theory of the Spherical or Conical Dome of Reinforced Concrete or Metal. William Cain. The domes considered are supposed to be solids of revolution, as to figure, and to be constructed of material such as metal or reinforced concrete, capable of sustaining either tensile or compressive stresses. 7800 w. Ills. Pro Am Soc of Civ Engrs—April, 1905. No. 69270 E.

Failures.

An Expert Report on the Collapse of Buildings in New York City. Report of the Board of expert engineers on the causes of the fall of several nearly completed buildings. Considers the failures were due to defective construction—slovenly mason work and poor mortar. 1200 w. Eng News—April 13, 1905. No. 68954.

Fireproof Construction.

Concrete Seat-Bank Construction in the Chicago Orchestra Building. Illustrated description of features in an auditorium where special effort has been made to secure fireproof construction. 1000 w. Eng News—April 6, 1905. No. 68839.

Foundations.

A Few Remarks on Foundations. L. L. Buck. Some remarks on the question of the distribution of the load. 1000 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69267 E.

Grain Elevator.

Large Grain Elevator at Weehawken. J. C. Irwin. Illustrated description of a 2,000,000 bushel fireproof elevator belonging to the New York Central. 2000 w. R R Gaz—Vol. XXXVIII. No. 14. No. 68821.

The Weehawken Elevator of the New York Central & Hudson River R. R. J. C. Irwin. Fully illustrated description of a 2,000,000 bushel fireproof elevator. 2300 w. Eng Rec—April 8, 1905. No. 68893.

Grandstand.

The Belmont Park Steel Grandstand. Illustrates and describes the engineering and architectural features of a steel grandstand at this race course on Long Island, near New York City. It is 116 ft. wide, 650 ft. long, and about 55 ft. high, having a seating capacity of 11000. 2500 w. Eng. Rec—April 22, 1905. No. 69217.

Reinforced Concrete.

Reinforced Concrete Resistance at Port Antonio, Jamaica Island. Illustrates and describes an unusual winter home recently completed. 1400 w. Eng Rec—April 8, 1905. No. 68897.

The Reinforced Concrete Pugh Power Building, Cincinnati, O. Illustrates and describes a building of this material, to be used for manufacturing purposes. 1500 w. Eng Rec—April 15, 1905. No. 68971.

See Also Civil Engineering, Bridges.

Simplon Tunnel.

The Construction of the Simplon Tunnel. Leon Monete. A very fully illustrated account of the work, including the project, the mechanical equipment, and the manner in which the numerous difficult engineering problems were solved. 3500 w. Engineering Magazine—May 1905. No. 69171 B.

MATERIALS OF CONSTRUCTION.

Brick.

Results of Tests of Common Building Brick for the Bureau of Buildings. New York City. Ira H. Woolson. Describes experiments including tests of transverse and crushing strength, absorption, fire and freezing tests. 3000 w. Eng News—April 13, 1905. No. 68951.

Cement.

Cement Posts. C. L. Catherman. Read before the Iowa Cement Users Convention. Discusses the proper making and reinforcing of cement posts, and problems arising in their use. 2000 w. Munic Engng—April, 1905. No. 69013 C.

Irregular Methods of Testing Cement. H. A. Schaffer. Read before the Assn. of Portland Cement Mfrs. Points out errors made by many cement testers employed by contractors, engineers, and architects. 4500 w. Cement Age—March, 1905. No. 68732.

Natural Hydraulic Cement. Edwin C. Eckel. Discusses the grinding of the clinker, and types of grinding machinery. 3000 w. Munic Engng—April, 1905. No. 69011 C.

Testing Cements and Asphalts. Prof. A. W. Dow. Digest of a report giving rules and methods recommended. 2500 w. Munic Jour & Engr—April, 1905. No. 68805 C.

The Cement Industry. Frederick W. Huber. Gives a classification of materials discussing their composition, and the process of manufacture of Portland cement. 5000 w. Cal Jour of Tech—Feb., 1905. No. 69023 C.

The Decomposition of Cements by Sea Water. Henri Le Chatelier. Abstract translation of a paper prepared for the St. Petersburg Congress of the International Society for Testing Materials. Specially considers the chemical action. 5200 w. Cement Age—March, 1905. No. 68731.

The Pacific Portland Cement Co. W. W. Whitton. An illustrated article describing the process of manufacture as carried out by this California company. 3800 w. Cal Jour of Tech—Feb., 1905. No. 69021 C.

Concrete.

Practical Notes on Concrete Manipulation. From a paper by Charles A. Matcham, before the Nat. Bldrs.' Sup. Assn. Describes methods of constructing buildings of concrete. Ills. 3300 w. Eng Rec—April 15, 1905. No. 68970.

The Proportions of Ingredients in Portland Concrete. Richard T. Dana. Gives diagrams showing amounts of cement, sand and stone or gravel in concrete for different percentages of voids; explaining method of use. 2400 w. Eng News—April 20, 1905. No. 69077.

Water Tightness of Concrete. Frederick W. Taylor, and Sanford A. Thompson. Selected from Taylor and Thompson's Treatise on Concrete. Plain and Reinforced. Information on methods of securing water tight work. 3500 w. Munic Engng—April, 1905. No. 69010 C.

Testing.

Regulations of the Bureau of Buildings, Borough of Manhattan, for the Testing of New Materials of Construction. Gives regulations based on common brick as a standard, using the results obtained by Prof. Ira H. Woolson. 1200 w. Eng News—April 13, 1905. No. 68952.

Timber.

Methods and Cost of Creosoting Timber. Oswald T. Dunn. Condensed from an article in *The Polytechnic.* Describes methods in use. 1400 w. Eng News—April 27, 1905. No. 69250.

The Strength of Timber Treated with Preservatives. From. Bul. U. S. Bureau of Forestry. Effect of steaming and different preservative chemicals and processes upon both green and seasoned lumber. 1400 w. St Ry Rev—April 15, 1905. No. 69068 C.

MEASUREMENT.

Formula.

A Simple Demonstration of the Prismoidal Formula. Gives a geometrical demonstration of this formula, showing its application. 700 w. Eng News—April 6, 1905. No. 68841.

Maps.

Municipal Sub-Surface Construction Maps. Herbert S. Wynkoop. A description of the Philadelphia plan of giving information to contractors which enables them to know the conditions below the surface, thus making possible the opening of streets for repairs and other work, and the quickest possible closing. Map. 1800 w. Eng Rec—April 1, 1905. No. 68830.

Sighting.

Aiming by Telescope Sight Compared with Aiming by Open Sights. Dr. S. Crapski. A physico-physiological study of the advantages gained by the use of telescopes in aiming and laying guns. Ills. 7300 w. Pro U S Nav Inst—March, 1905. No. 69098 G.

Stream Discharge.

A Convenient Method for Determining the Discharge of Streams and Canals. T. H. Cunningham. Describes a method in the use of which the intervals between meter stations may be made any convenient distance. 350 w. Eng News—April 6, 1905. No. 68843.

A Method of Computing Flood Discharge and Cross-Section Area of Streams. E. G. Murphy. Gives methods for finding these measurements, with tables. 1500 w. Eng News—April 6, 1905. No. 68838.

Wind Measurements.

The Julliot Anemometric Balloon. Translated from *La Nature*. Illustrated description of an apparatus for measuring the direction and velocity of the wind at different heights. 800 w. Sci Am Sup—April 15, 1905. No. 68937.

MUNICIPAL.

Boulevard.

Construction of Sections 3 and 4, Riverside Drive Extension, New York. Illustrated description of the construction of the drive from 145th St. to 158th St. 1000 w. Eng Rec—April 15, 1905. No. 68969.

Dust.

Methods of Dust Abatement and Prevention (Les Moyens de Combattre ou d'Empêcher la Poussière). G. Forestier. A discussion of methods of sprinkling and of preventing the formation of dust on streets and highways. 7000 w. Mem Soc Ing Civ de France—Dec., 1904. No. 69160 G.

Fire Engines.

The Modern Steam Fire Engine. F. F. Loomis. Abstract of a paper before the Ohio Soc. of Mech. & Steam Engrs. Considers the requirements of fire engines and describes modern engines and the methods of handling that will give the best results. 1500 w. Ir Age—April 6, 1905. No. 68791.

Maps.

See Civil Engineering, Measurement.

Pavements.

Specifications for Laying Asphalt Pavements. Gives the new specifications for the laying of asphalt pavements in the city of San Francisco. 1600 w. Cal Jour of Tech—Feb., 1905. No. 69024 C.

Refuse.

British Refuse Destructors and American Garbage Furnaces. An editorial on the poor results in America as compared with Great Britain, and some of the causes. 2800 w. Eng News—April 13, 1905. No. 68953.

British Refuse Destructors. Notes on the destructors of four London boroughs giving a general idea of the conditions. 6500 w. Eng News—April 13, 1905. Serial. 1st part. No. 68950.

The Land Disposal of Garbage: An Opportunity for Engineers and Contractors. Editorial on the experiment at St. Louis, where the garbage is plowed into the land on an island in the river. 2500 w. Eng News—April 6, 1905. No. 68844.

Septic Tanks.

The Mosman Septic Tanks, Sydney, N. S. W. Notes from the official report of L. A. B. Wade concerning the construction of four septic tanks, a grit chamber, eight filter beds and two gear chambers. 1000 w. Eng Rec—April 22, 1905. No. 69218.

Sewage.

Sewage Purification Plants in Ohio. Information from the annual report of the State Board of Health of Ohio, with illustrations of some of the plants. 2500 w. Munic Engng—April, 1905. No. 69009 C.

The Bacteriolysis of Peptones and Nitrates. Stephen De M. Gage. An investigation into types of bacteria normally present in sewage and the effluents of sewage disposal systems. 12000 w. Tech Qr—March, 1905. No. 69006 E.

The Interpretation of a Sewage Analysis. Earle B. Phelps. Considers raw or untreated sewages and septic sewages and the interpretation of analytical data. 7400 w. Tech Qr—March, 1905. No. 69007 E.

Sewers.

The Cost of Reinforced Concrete Sewers. Information given by Walter C. Parmley in a recent paper before the Boston Soc. of Civ. Engrs., referring to work done on sewers in Cleveland during the last three years. 1500 w. Eng. Rec—April 8, 1905. No. 68892.

WATER SUPPLY.

Amsterdam.

The Water Supply of Amsterdam, Holland. W. P. Mason. Explains how the supply of water is secured from the sand-dunes. 1000 w. Eng News—April 27, 1905. No. 69248.

Artesian Wells.

Artesian Flows from Unconfined Sandy Strata. Myron L. Fuller. Describes flows from artesian wells sunk wholly in sand, discussing the cause. 1200 w. Eng News—March 30, 1905. No. 68832.

The New Artesian Water Supply of Ithaca, N. Y. F. L. Getman. Describes the geological formations, the distribution and arrangement of the wells, the collection system, and costs. Ills. 2800 w. Eng News—April 20, 1905. No. 69081.

Conduits.

The Torresdale Conduit. John W. Hill. A fully illustrated detailed description of a large inverted siphon belonging to the filtration system of the water supply of Philadelphia, with the history of its construction, examination, and present condition. General discussion. 15000 w.

Pro Engrs' Club of Phila—April, 1905. No. 69034 D.

Evaporation.

Evaporation Observations in the United States. Herbert Harvey Kimball. Read before the Irrigation Congress, at El Paso, Tex. Gives tabulated results of measurements of evaporation made at various points, with explanatory remarks. Map. 2000 w. Eng News—April 6, 1905. No. 68837.

Filtration.

A Reinforced Concrete Filtration Plant at Marietta, Ohio. Illustrations, detail sections and description of construction. 1200 w. Eng Rec—April 22, 1905. No. 69213.

The Sand Filtration Plant of the Indianapolis Water Works. W. C. Mabee. From a paper before the Indianapolis Tech. Club. Illustrated detailed description of the plant and information concerning the source of supply. 3200 w. Munic Engng—April, 1905. No. 69012 C.

Gloucester, Mass.

Haskell's Brook Reservoir and Dam, Gloucester, Mass. H. W. Spooner. Illustrates and describes the construction of the new impounding reservoir, the preparation of the basin, and the building of the dam. 2000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69054 F.

Irrigation.

The Irrigation Project of the Canadian Pacific Railway. Illustrated description of the system of irrigation undertaken by this railway for the purpose of promoting the settlement of that portion of its land which requires irrigation. 2800 w. Eng News—April 27, 1905. No. 69246.

The Irrigation System of Ontario, California—Its Development and Cost. F. E. Trask. Treats of the development and present status of an irrigation plant in the "Orange Belt" of Southern California, and gives details and cost of a system designed to meet exacting demands for "high duty and maximum utility." 2200 w. Ills. Pro Am Soc of Civ Engrs—April, 1905. No. 69268 E.

Pipe Laying.

Method of Laying a Triple Line of 60-in. Cast-Iron Pipe. Seth M. Van Loan. Brief Illustrated description of methods used in Philadelphia for filtered water distribution from Torresdale filters. 1200 w. Eng News—April 6, 1905. No. 68835.

Pumping.

The Direct Pumping Method of Water Supply in Use at Taunton, Mass. George A. King. Gives an account of the reasons for installing this system, and describes its features; also its operation and cost of working. 2000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69053 F.

Pump Well.

Difficulties with a Pump Well. Illustrated description of the construction of a pump well at Atlantic City, N. J., which was accomplished with some difficulty. 1200 w. Eng Rec—April 1, 1905. No. 68828.

Reservoirs.

Repairs to the Lining of a Small Reservoir on Powder Horn Hill, Chelsea, Mass. Caleb Mills Saville. Illustrated notes on a piece of work recently carried out, giving methods and cost. 2000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69057 F.

The Opening of the New Croton Reservoir. An interesting account, fully illustrated, of the rise of water behind the new dam, after the shutting down of the gates, with other information about the water supply of New York City. 1800 w. Sci Am—April 15, 1905. No. 68936.

St. Louis.

Ice at the Intake of the St. Louis Water Works. Edward E. Wall. Describes the arrangements for protecting the intake tower from ice, and an account of the trouble during the severe weather of the past winter. Ills. 900 w. Eng Rec—April 15, 1905. No. 68973.

Stave Pipe.

Wooden Stave Pipe. W. C. Hawley. Brief description of the construction, discussing the merits, and giving extracts from specifications. Discussion. Ills. 5400 w. Pro Engrs' Soc of W Penn—April, 1905. No. 69038 D.

Sterilization.

The Water Sterilization Works at Saint Maur. Emile Guarini. Illustrates and describes experimental works for the sterilization of water by the use of ozone at these works in Paris. 1500 w. Elec Engr, Lond—April 14, 1905. No. 69233 A.

Valves.

Regulating Valve. J. W. Ledoux. An illustrated description of an apparatus for regulating the flow of water with gravity supplies. Discussion. 1700 w. Pro Engrs' Club of Philadelphia—April, 1905. No. 69036 D.

Water Tower.

Description of Concrete-Steel Water Tower and Standpipe at Fort Revere, Hull, Mass. Leonard S. Doten. Illustrated detailed description of unusual concrete steel construction. Discussion. 2500 w. Jour N Eng W-Wks Assn—March, 1905. No. 69055 F.

Water Tank and Tower for East Providence, R. I. F. M. Bowman. Illustrated detailed description of a structure the largest of its type. Also discussion. 4000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69056 F.

Water-Works.

The New Gravity Water-Works at Hudson, N. Y. Illustrates and describes a storage reservoir and pipe line just completed. 2800 w. Eng Rec—April 1, 1905. No. 68824.

Wisconsin.

The Public Water Supplies of Wisconsin. W. C. Kirchoffer. A report of the sources of supply, quality and treatment of waters, &c. 3800 w. Wis Engr—April, 1905. No. 69243 D.

WATERWAYS AND HARBORS.

Argentina.

The New Port of Rosario in the Argentine Republic (Le Nouveau Port du Rosario dans la République Argentine). Georges Hersent. A very full account of the new harbor works at Rosario, on the Parana, above Buenos Ayres. 7500 w. 2 plates. Mem Soc Ing Civ de France—Jan., 1905. No. 69162 G.

Bruges.

The Harbors and Maritime Canal of Bruges (Les Ports et le Canal Maritime de Bruges). L. Coiseau. A very full account of the ship canal connecting Bruges with the North Sea; together with other harbor improvements. 16,000 w. 9 plates. Mem Soc Ing Civ de France—Dec., 1904. No. 69161 G.

Canada.

Port Colborne Harbor Works. J. M. Hogan. Student's prize paper read before the Canadian Soc. of Civ. Engrs. Illustrated description of harbor improvements at the Lake Erie end of the Welland canal. 1000 w. Can Engr—April, 1905. Serial. 1st part. No. 68871.

Docks.

Fire Protection of the Stuyvesant Docks. H. W. Parkhurst. Illustrations of the destruction by fire of these New Orleans docks, with remarks on the provisions for fighting fire and preventing its spreading. 1000 w. R R Gaz—Vol. XXXVIII. No. 13. No. 68818.

Dredgers.

European and American Dredges. Frank C. Perkins. Illustrates and describes various types used. 2000 w. Min Rept—April 13, 1905. No. 68960.

Modern Sea-Going Dredgers. Illustrations, with description of the dredgers "Savannah" and "Coronation," the latter a British dredger. 2500 w. Naut Gaz—April 6, 1905. No. 68876.

Stern-Wheel Government Dredge for Florida Waters. Illustrated description of the dredge and snag-boat "Florida," built for service on the St. John and other Florida rivers. 2800 w. Naut Gaz—April 13, 1905. No. 68955.

Drydock.

New Masonry Drydock at the Boston Navy Yard. Illustrated description of the fine stone-and-concrete drydock recently completed. It is one of the largest in the world and embodies all the modern improvements. 1200 w. Sci Am—April 29, 1905. No. 69253.

Egypt.

Inland Navigation in Egypt. Sir Hanbury Brown. A review of what has been done to develop the inland waterways of Egypt, as a contribution to the collection of facts concerning the policy of nations with regard to their inland waterborne transport. Map. 3500 w. Engr, Lond—March 31, 1905. Serial. 1st part. No. 68909 A.

Lighthouses.

Improvements in English Lighthouses. Illustrated description of new lanterns recently placed at St. Catherine's and two other electrically illuminated English lighthouses. 2000 w. Engr, Lond—April 14, 1905. No. 69238 A.

Liverpool.

The Improvement of the Port of Liverpool (Les Améliorations du Port de Liverpool). Bryson Cunningham. With plans of the docks and a review of the development of the port. 1800 w. Génie Civil—April 1, 1905. No. 69117 D.

Missouri.

Technical Methods of River Improvement, as Developed on the Lower Missouri River by the General Government from 1876 to 1903. Discussion of the paper by S. Waters Fox. Ills. 7700 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69271 E.

Nile.

The Asyut Barrage Across the Nile. Notes from a paper by George H. Stephens, presented before the Inst. of Civil Engrs., describing this work in Egypt. Ills. 2500 w. Eng Rec—April 15, 1905. No. 68968.

The Safety of the Assuan Dam. Reviews facts concerning the structure, and the recently printed opinions of Mr. Atcherley. 2000 w. Eng Rec—April 22, 1905. No. 69215.

Ohio.

From Pittsburg to Tidewater. An illustrated article discussing the proposed canalization of the Ohio river from Pittsburg to the Mississippi. 2500 w. Marine Rev—April 6. 1905. No. 68877.

Ohio River and Its Improvement. Gives a statement showing the distribution and fall of the river, its tributaries, with the improvements under discussion, the commerce of the river, &c. 4500 w. Marine Rev—April 13. 1905. No. 68931.

Panama.

A New Plan for the Panama Canal. An explanation of the project submitted by Lindon W. Bates, which provides for terminal lakes and a 20-foot summit level. Also suggests an alternative plan with higher summit level. 1500 w. Eng Rec—April 22, 1905. No. 69216.

Machinery On the Panama Canal. H. Prime Kieffer. An illustrated account of the repair work under way to make ready for use the machinery already on the Isthmus, with some information relating to the work to be accomplished. 3000 w. Mod Mach—April, 1905. No. 68733.

Modern Excavating Machinery for the Panama Canal. A. W. Robinson. Mr. Robinson's second paper gives a general review of the latest and most powerful types of excavating and dredging machinery available for use on the Panama canal works. 2500 w. Engineering Magazine—May, 1905. No. 69170 B.

Panama in French Canal Times. W. F. Dennis. Notes on the conditions of the isthmus during the operations of the French Company are reviewed. Ills. 3000 w. Eng Rec—April 1, 1905. No. 68825.

Report of the Chief Engineer of the Isthmian Canal Commission. Report of John F. Wallace, with editorial comment. 8500 w. Eng News—April 20, 1905. No. 69083.

Stream Discharge.

See Civil Engineering, Measurement.

Streams.

Characteristics of Two Companion Streams of the Plains. E. C. Murphy. Information in regard to the Neosho and Verdegris Rivers, two tributaries of the Arkansas River, showing remarkable fluctuations in flow. 2500 w. Eng News—April 27, 1905. No. 69247.

Wharf.

The Steel and Concrete Wharf at Tampico. Information concerning this unusual wharf, taken from a monograph by E. H. Connor. Describes the main and lateral wharves and their construction. 2000 w. Eng Rec—April 8, 1905. No. 68895.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The Power Plant of a Modern Telephone Exchange. A. Dallam O'Brien. Considers methods employed in charging the storage batteries and related matters. 3000 w. Am Elect'n—April, 1905. No. 68812.

Induction.

The Reduction of Induction in Cables for Weak Currents (Ueber die Vermeidung der Induktion bei Schwachstromkabeln). J. Schmidt. A discussion of the best arrangement of wires in telephone and telegraph cables to minimize induction effects. 3500 w. Zeitschr f Elektrotechnik—March 10. 1905. No. 69153 D.

Pupin System.

The First Pupin Telephone Installation in Austria (Die Erste Pupin'sche Telephonleitung in Oesterreich). R. Nowotny. An account of the construction and operation of the line between Vienna and Innsbruck, using the Pupin inductance coils. 4000 w. Zeitschr f Elektrotechnik—March 26. 1905. No. 69154 D.

Space Telegraphy.

Artom Selective System of Wireless Telegraphy. A. Frederick Collins. An account of experiments made with this new wireless system of telegraphy with elliptical or circular rays of electric power. 1800 w. Elec Wld & Engr—April 22, 1905. No. 69212.

New American System of Wireless Telegraphy. James Foster King. A statement of the transmitting formula of the writer's system. 1000 w. Elec Wld & Engr—April 15, 1905. No. 68965.

The Control of Action at a Distance by Means of Electric Waves (Distribution et Controle d'Actions Produites à Distance par les Ondes Electriques). Edouard Branly. Discussing the practicability of employing the methods of space telegraphy for starting motors, igniting explosives, and similar actions at a distance. 1200 w. Comptes Rendus—March 20, 1905. No. 69123 D.

Telephony.

A New Underground Cable System. Axel Hultman. Illustrated description of a method worked out by the writer. 1000

w. Elec Rev, Lond—April 14, 1905. No. 69229 A.

DISTRIBUTION.

Cables.

The Arrangement and Installation of Cable Protection Devices (Ueber Kabelschulzhullen deren Herstellung und Verlegen). J. Schmidt. With especial reference to the construction of underground conduits and methods of providing external protection for cables laid beneath the surface. Two articles—8000 w. Electrotech Zeitschr—April 16, 13, 1905. No. 69150 each B.

Converters.

The Starting of Rotary Converters. Sydney Woodfield. Considers briefly all the methods one is likely to meet with. 2500 w. Elec Rev, Lond—April 21, 1905. No. 69259 A.

Cut-Outs.

Low-Tension Thermal Cut-Outs. Alfred Schwartz and W. H. N. James. A brief résumé of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. States the requirements of an efficient protective device and shows the influences that may affect a fuse wire. Discussion. 3000 w. Elec Engr, Lond—March 24, 1905. No. 68749 A.

Safety Switch.

Electric Switches and Description of a Patent Safety Switch for Use in Mines. William Maurice. Read at Nottingham meeting of Nat. Assn. of Col. Mgrs. Gives the rules relating to the design and application of switches formulated by the Inst. of Elec. Engrs., and gives an illustrated description of design. 2000 w. Ir & Coal Trds Rev—April 7, 1905. No. 68991 A.

Switchboards.

Notes on the Use of Instruments on Switchboards. F. P. Cox. To introduce a discussion on the more important features of instrument engineering, confining the remarks to the conditions which are found on switchboards in central stations. 1200 w. Am Inst of Elec Engrs—April, 1905. No. 69029 D.

Transformers.

Care and Operation of Transformers. M. A. Sammett. Suggestions for the care and operation of both service and station transformers. 2500 w. Can Elec News—April, 1905. No. 69060.

Flux Distribution in Design. A. Press. Gives two cases, showing the effect of the lack of uniformity of distribution of magnetic flux in transformers. Also editorial. 1700 w. Elec Wld & Engr—April 8, 1905. No. 68890.

Transformer Practice. C. W. Humphrey. Describes some of the tests necessary to judge of the values of transformers, explaining the methods used and the reasons for them. 2500 w. Elec Wld & Engr—April 8, 1905. No. 68889.

Wiring.

How to Remember the Wire Table. Charles F. Scott. An explanation of a few simple relations of the wire table for the B. & S. gauge copper wire that will enable the whole table to be constructed mentally. 1400 w. Elec Club Jour—April, 1905. No. 69091.

The Inspection of Electrical Conductors, With Especial Reference to Fire Protection. Washington Devereux. A statement of the progress and present condition of the science of interior wiring for the protection of buildings from fire. 4000 w. Jour Fr Inst—April, 1905. No. 69037 D.

ELECTRO-CHEMISTRY.

Accumulators.

Care and Preservation of the Lead Cell Exide Storage Battery. Excerpts from a recently issued pamphlet giving instructions for the proper care and preservation of this storage battery. 2400 w. Automobile—April 8, 1905. Serial. 1st part. No. 68874.

Recent Improvements in Portable Accumulators (Die Letzten Neuerungen auf dem Gebiete Transportabler Akkumulatoren). E. Sieg. Describing especially alkaline batteries of the Edison-Jungner type, showing the effective weight per unit of various types. 4000 w. Elecktrotech Zeitschr—March 30, 1905. No. 69.-149 B.

Address.

The Rôle of Electrochemistry in Modern Technology (Die Rolle der Elektrochemie in der Modernen Technik). Dr. Haber. An address showing the relation between electrochemistry and engineering work. 4500 w. Zeitschr d Ver Deutscher Ing—March 18, 1905. No. 69102 D.

Copper.

Investigations upon the Electrolytic Properties of Copper Sulphide (Versuche ueber das Elektrolytische Verhalten von Schwelfelkupfer). G. Bödlander & K. S Idaszewski. Data and results of exhaustive experiments bearing upon the elektrolytic separation of copper direct from the sulphide. 7500 w. Zeitschr f Elektro-Chemie—March 24, 1905. No. 69.-157 D.

Electrolytic Slime.

Electrolytic Treatment o. Electrolytic Slime. Anson G. Betts. An illustrated account of experimental investigation. 4500 w. Elec-Chem & Met Ind—April, 1905. No. 68775 C.

Furnaces.

Experiments with an Electro-Thermic Muffle Furnace. F. A. J. Fitz-Gerald. Illustrated detailed description of the construction of an electric muffle furnace, and an account of experiments made in it. 3800 w. Elec-Chem & Met Ind—April, 1905. No. 68773 C.

Refractory Materials for Furnace Linings. E. Kilburn Scott. A Faraday Society paper, giving details on the use of carborundum and of electrically shrunk magnesite for furnace linings. 2500 w. Elec-Chem & Met Ind—April, 1905. No. 68774 C.

ELECTRO-PHYSICS.

Induction Coil.

The Construction of a Four-Inch Spark Induction Coil. Thomas R. Hopper. Illustrated detailed description. 3000 w. Sci Am Sup—April 8, 1905. No. 68855.

Insulation.

Tests to Determine the Comparative Heat Conduction and Radiation of Insulating Varnishes. John C. Dolph. Describes tests made to determine the combined heat radiation and conduction of various varnishes, giving results. 1800 w. Elec Rev, N. Y.—April 1, 1905. No. 68789.

Magnetism.

Recent Experiments on the Nature of Magnetism. Emile Guarini. A review of some of the results of researches by Herr Joannes Zacharias. Ills. 3300 w. Sci Am Sup—April 15, 1905. No. 68939.

Unsolved Problems.

Unsolved Problems in Electrical Engineering. Col. R. E. B. Crompton. The "James Forrest" lecture, delivered at the Inst. of Civ. Engrs., April 10, 1905. Classifies the problems into two groups, those set by Nature, and those which have developed in applying electrical energy to man's service. Discusses some of the problems. Full paper. 8500 w. Engng—April 14, 1905. No. 69234 A.

Unsolved Problems in Electrical Engineering. Col. R. E. B. Crompton. Abstract of the "James Forrest" lecture, delivered before the Inst. of Civ. Engrs., with editorial. Discusses a few of the most pressing problems. 5800 w. Elect'n, Lond—April 14, 1905. No. 69231 A.

Waves.

Methods of Decomposing Sine Waves (Methods der Zerlegung in Sinuswellen). C. Runge. A mathematical discussion of the analysis of periodic wave action and its separation into its simple elements. 4000 w. Elektrotech Zeitschr—March 16, 1905. No. 69144 B.

GENERATING STATIONS.

Costs.

An Analysis of Central Station Operating Costs and Revenue. H. S. Knowlton. A discussion of the costs of electric lighting as deduced from the report of the Massachusetts State Board, covering returns from 115 modern stations. 2500 w. Engineering Magazine—May, 1905. No. 69176 B.

Dynamo.

A New Generator. William Ashabel Johnson. Illustrated description of an alternating current generator of the revolving field type. 1800 w. Can Elec News—April, 1905. No. 69061.

Erection.

The Erection of Alternating-Current Machines. R. Scott. Describes the three types of machines and discusses the erection and preliminary operation of alternators. 4800 w. Power—April, 1905. No. 68795 C.

Generating Sets.

The Economy of Small Generating Sets (Les Petits Groupes Electrogenes considérés au Point de Vue de la Production Economique de l'Energie Electrique). R. Friédérich. An examination of the cost of electricty as generated by small steam, gas, and oil engines. 3000 w. Revue Technique—March 25, 1905. No. 69,142 D.

Hydro-Electric.

Harnessing the Victoria Falls for Electrical Power. An illustrated article giving information of the power scheme to be carried out in Africa on the Zambesi River. 1500 w. Sci Am—April 29, 1905. No. 69254.

Headworks of the Plant of the Toronto & Niagara Power Co., Niagara Falls. Illustrations, showing the general features of the headworks with description of the construction. 1000 w. Eng Rec—April 8, 1905. No. 68894.

Hydro-Electric Power Development and Transmission in California. Robert McF. Doble. Brief historical review of the methods of transmitting the power of California mountain streams over long distances. Ills. 9500 w. Jour Assn of Engng Socs—March, 1905. No. 69045 C.

Largest Electric Water Power in Maine. Illustrated detailed description of the plant at Deer Ribs on the Androscoggin River, near Lewiston, Me. 2800 w. Elec Wld & Eng—April 8, 1905. No. 68888.

Niagara Power at Goat Island. Alton D. Adams. A discussion of present conditions at Niagara Falls, and the danger of drying up the American falls, and in that case, the value of Goat Island as a power site. 1600 w. Sci Am—April 15, 1905. No. 68935.

The Gersthofen Hydro-Electric Power Station. Notes on the extensive utilization of water power in the neighborhood of Augsburg, Bavaria, with illustrated detailed description of the plant named. 1700 w. Engr, Lond—April 14, 1905. No. 69240 A.

The 36,000-Volt Hydro-Electric Installation of the Cellina (Italy). Enrico Bignami. Illustrates and describes the first installation on the Cellina River, which is to supply electrical energy in the district of Venice. 2200 w. Elec Rev, Lond—April 7, 1905. No. 68986 A.

Use of Pacific Coast Water Powers in Electrical Operation of Railroads. Robert McF. Doble. Conclusion of a paper read before the Pacific Coast Ry. Club. An illustrated description of the single phase alternating-current equipment, and a review of what has been accomplished in California and other Pacific Coast States. 6000 w. Jour of Elec—April, 1905. No. 68822 C.

Water-Power Plant for a Cordite Factory in India. Illustrated description of the hydraulic plant recently erected to furnish the power required for electrically driving the new Government cordite factory in the Nilghiri Hills, India. 1500 w. Engr, Lond—March 31, 1905. No. 68911 A.

Labor Saving.

Labor-Saving Machinery in Central Stations. Discusses the reckless adoption of labor saving machinery under unsuitable conditions. 2000 w. Elec Rev, Lond—April 7, 1905. No. 68987 A.

Management.

Central Station Management. George S. Carson. Suggestions tending to economy of operation, and good service. 1700 w. Elec Wld & Engr—April 15, 1905. No. 68966.

Power Plant.

The Water and Electric Power Plant of the Utah Sugar Company. W. P. Hardesty. Illustrated description of a plant built entirely for irrigation, but made available for power. 3500 w. Eng News—April 13, 1905. No. 68948.

Tropical Plant.

The Electric Plant at Medellin, Colombia, S. A. C. H. Hines. Describes a typical plant in the tropics, showing the difficulties to be overcome. 1500 w. Elec Wld & Engr—April 15, 1905. No. 68963.

University Plant.

The Central Light, Heat and Power Plant at the University of California. G. C. Noble. Illustrated description of this new plant which supplies light, heat, and power for the various buildings and laboratories, and also serves as an experimental equipment. 2500 w. Engr, U S A—April 15, 1905. No. 68905 C.

LIGHTING.

Illumination.

A Field for the Illuminating Engineer. L. B. Marks. Discusses the proper distribution of light in interiors, and the value of diffused light. 1000 w. Elec Rev, N Y—April 15, 1905. No. 68947.

Lamps.

Modern Arc Lamps. John Howatt. Discusses the requisites of the ideal arc lamp, and the changes and improvements during the last ten years, giving illustrated descriptions of different types. 3000 w. Am Elect'n—April, 1905. No. 68810.

Mercury Vapor.

Principles and Applications of Mercury Vapor Apparatus. F. von Keller. Briefly considers its application in the lamp, the converter, the interrupter and the alternating current switch. General discussion. 5500 w. Pro Engrs' Club of Phila—April, 1905. No. 69033 D.

Nernst.

Notes on the Use of Rare Earths in Electric Illuminants. Murray C. Beebe. Information of interest concerning the mixtures used as glowers in lamps of the Nernst type. 4500 w. Pro Engrs' Soc of W Penn—April, 1905. No. 69039 D.

Titanium Arc.

The Metallic Arc. Isador Ladoff. Reports experiments made with titanium pencils, giving results. Also editorial. 3500 w. Elec Wld & Engr—April 22, 1905. No. 69209.

MEASUREMENT.

Dynamo Testing.

A New Method of Testing Alternating-Current Generators. H. M. Hobart and F. Punga. Describes a method requiring no alterations to the windings and no greater expenditure of energy than is necessary for covering the internal losses. 1200 w. Elec Wld & Engr—April 22, 1905. No. 69210.

Frequency Meters.

The Calibration of Frequency Meters, with Especial Reference to the Slaby Multiplication Scales (Die Eichung von Wellenmessern insbesondere beim Slabyschen Multiplikationsstabe). P. Drude. Describing both the direct and the indirect process of calibration, according to the Slaby method. With tables of instrumental corrections. [illegible]00 w. Elektrotech Zeitschr—April 13, 1905. No. 69152 B.

Metering.

Some Notes on Polyphase Metering. J. D. Nies. Discusses methods of polyphase metering and the errors that occur, concluding that in metering three-phase systems, three separate single-phase meters make the best arrangement when the highest degree of accuracy is demanded. 4800 w. Am Inst of Elec Engrs—April, 1905. No. 69028 D.

Meters.

Maintenance of Meters. W. J. Mowbray. On the necessity of periodic overhauling to maintain meter accuracy. 1200 w. Am Inst of Elec Engrs—April, 1905. No. 69031 D.

Right Angle Connections, with Especial Reference to the Action of Magnetic Fields (Ueber 90° Schaltungen mit besonderer Berücksichtigung Magnetisch Verketteter Stromverzweigungen). Emil Waltz. An elaborate discussion of the relation of alternating currents and magnetic fields in connection with the design of alternating current meters. Three articles. 12000 w. Elektrotech Zeitschr—March 9, 16, 23, 1905. No. 69143 each B.

Meter Testing.

The Meter Department of the New York Edison Company. Illustrated description of the methods employed to secure accuracy of electricity meters. 2300 w. Elec Wld & Engr—April 1, 1905. No. 68806.

Oscillograph.

A New Oscillograph Wave Tracer. Rudolf Goldschmidt. An illustrated description of the apparatus, explaining the principle. 800 w. Elect'n, Lond—April 14, 1905. No. 69230 A.

Notes on Some Effects in Three-Phase Working. W. M. Thornton. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. Gives results of investigations with the oscillograph which were undertaken with the object of deciding questions of importance in the working of a polyphase system. 3300 w. Elect'n, Lond—April 14, 1905. No. 69232 A.

The Oscillograph and Its Uses. Lewis T. Robinson. Outlines the steps that have led to present methods in use for recording the wave forms of electric currents, describing the devices now employed and the uses to which they may be put. Ills. 3500 w. Am Inst of Elec Engrs—April, 1905. No. 69030 D.

Photometer.

On a Scale of Color-Values and a New Photometer. Arthur H. Munsell. An illustrated description of the Munsell photometer, explaining the principle of the instrument, its calibration, and giving directions for its use in measurements of light and color. 4000 w. Tech Qr—March, 1905. No. 69008 E.

Rheostats.

Bimetallic Rheostats. F. Punga. Illustrates and describes a rheostat devised by Mr. Hobart, in which iron and copper are combined. 800 w. Elec Rev, Lond—March 31, 1905. No. 68902 A.

Voltmeter.

An Electrostatic Voltmeter for High Pressures (Ein Elektrostatisches Voltmeter für Hohe Spannungen). A. Grau. Describing a form of electrostatic voltmeter in which oil is used as the dielectric instead of air, and applicable for pressures up to 90,000 volts. 1800 w. Elektrotech Zeitschr—March 23, 1905. No. 69145 B.

Wattmeter.

Single Wattmeter on Edison Three-Wire System. L. A. Freudenberger. Explains the three possible methods of connecting the armature of the recording wattmeter, examining them as to their relative errors. 700 w. Elec Wld & Engr—April 15, 1905. No. 68964.

MOTORS.

Induction Motors.

The Slip of an Induction Motor. B. F. Bailey. Describes the method of measuring the slip which is used in the electrical engineering laboratory of the University of Michigan, which requires only the simplest apparatus and does not involve any change in the connections of the motor. Also editorial. 1700 w. Elec Wld & Engr—April 22, 1905. No. 69208.

Motor Losses.

The Distribution of Losses in Non-synchronous Induction Motors (Verlusttrennung bei Asynchronen Drehstrommotoren). W. Angermann. An analysis of the copper, iron, and friction losses in induction motors, with diagrams showing their distribution. 5000 w. Elektrotech Zeitschr—March 30, 1905. No. 69146 B.

Repulsion Motors.

The Best Arrangement of Windings and Brushes for Compensated Repulsion Motors (Die Günstigste Anordnung von Wickelungen und Bürstenstellungen bei Kompensierten Repulsionsmotoren). Ernst Danielson. An examination of the most efficient windings, with especial reference to the Latour motor. 1500 w. Elektrotech Zeitschr—April 6, 1905. No. 69151 B.

Static Motor.

How to Make an Oscillating Static Electric Motor. Howard B. Dailey. Working drawings and suggestions for the construction of an experimental static motor. 1200 w. Sci Am Sup—April 29, 1905. No. 69256.

Variable Speed.

Notes on Heating and Sparking Limits in Variable Speed Motors. A. H. Bate. Read before the Birmingham Loc. Sec. Notes the three ways of varying the speed of a shunt motor, the factors that determine the sparking limits, and discusses the way these methods offset the heating and sparking limits. 2500 w. Inst of Elec Engrs—March 15, 1905. No. 69260 D.

TRANSMISSION.

Arresters.

Protective Apparatus. N. J. Neall. An illustrated article explaining static discharges and the equivalent spark gap, and the development of the multi-path arrester. 1800 w. Elec Club Jour—April, 1905. No. 69027.

The Arrangement of Lightning Arresters and the Influence of Choke Coils (Die Schaltung der Blitzableiter und der Einfluss von Drosselspulen). F. Neesen. An examination of various methods of connecting lightning arresters, comparing different designs. 4000 w. Elektrotech Zeitschr—March 30, 1905. No. 69148 B.

Cable Insulation.

The Insulation Resistance of High-Pressure Cables with Impregnated Paper Insulation (Der Isolationswiderstand von Hochspannungskabeln mit Imprägnierter Papierisolation). P. Humann. Data and results of insulation tests on paper covered cables. 1800 w. Elektrotech Zeitschr—March 30, 1905. No. 69147 B.

Long Distance.

Weak Points in Long-Distance Electric Transmission. James C. Bennett. Outlines the nature of the service required for lead-smelting, and some of the problems to be solved, and the trouble arising from interrupted service. 2500 w. Jour Assn of Engng Socs—March, 1905. No. 69046 C.

INDUSTRIAL ECONOMY

Apprenticeship.

The Apprenticeship Question in America. Frank T. Carlton. Discusses briefly the sources from which skilled workers may be drawn; how they are to be trained; and what should be the proportion of apprentices to journeymen. 1600 w. Cassier's Mag—April, 1905. No. 69202 B.

Cost Keeping.

Foundry Cost Accounts. John A. Makens. Read before the Phila. Found. Assn. Discusses the principles involved. 3500 w. Ir Age—April 13, 1905. No. 69020.

Cost Keeping on General Contract Work. A. W. Buel. Mr. Buel's second paper reviews the working systems of several successful contractors with forms and detailed examples of their application. 3500 w. Engineering Magazine—May, 1905. No. 69177 B.

Education.

Trade Schools. Edward Thomas Hewitt. Discusses the value of the trade school in fitting young men for useful lives, the present conditions, the instruction given in various schools, &c. 5000 w. Jour Assn of Engng Socs—March, 1905. No. 69047 C.

Exposition.

The Universal Exposition at Liége, 1905 (L'Exposition Universelle de Liége en 1905). L. Ramakers. A general account of the forthcoming exposition, with plans of the grounds and views of the partially completed buildings. 2000 w. Génie Civil—April 8, 1905. No. 69119 D.

Legislation.

A New and Important Law Affecting Sub-Contractors and Sellers of Material to Parties Holding Government Contracts. An explanation of a recent law passed by the U. S. Congress. 1500 w. Eng News—March 30, 1905. No. 68834.

London Electricity Bills. Considers bills before the English Parliament which are of extreme importance to the electrical industry. 4800 w. Engr, Lond—March 24, 1905. Serial. 1st part. No. 68758 A.

Metal Markets.

The Price Fluctuations of Certain Metals in the Years 1903-1904 (Preisbewegung einiger Metalle in den Jahren 1903 und 1904). B. Neumann. A tabulated view of prices of zinc, tin, lead, and silver for 1903 and 1904, with diagrams giving curves for the continuous price fluctuations. 2000 w. 7 plates. Glückauf—April 8, 1905. No. 69136 B.

Stores.

The Stores System of the National Acme Manufacturing Company. A. W. Henn. A detailed account of the practical working system of a shop making automatic screw machines, with examples of forms and methods. 1500 w. Engineering Magazine—May, 1905. No. 69173 B.

Tariff.

Machine Tools and the Tariff. Fred A. Geier. Gives information concerning rates in the various countries, and discriminations in some countries against America. 1600 w. Ir Age—April 20, 1905. No. 69005.

Training.

Training of Managers and Foremen at the Royal Ordnance Factories. Memorandum with regard to the report by the Foremen's Qualifications Committee on matters relating to the Royal Ordnance Factories. 1400 w. Mech Engr—April 8, 1905. No. 68983 A.

Works Management.

Machine Shop Management. Oscar E. Perrigo. Describes methods for ascertaining and apportioning the fixed charges, office and salary, and miscellaneous expenses. 5800 w. Ir Trd Rev—April 6, 1905. No. 68780.

MARINE AND NAVAL ENGINEERING

Battleships.

The First-Class Japanese Battleship Kashima. Gives eight pictures, showing the different stages of progress in the building of the ship, with information in regard to it. 2000 w. Engr, Lond—March 24, 1905. No. 68759 A.

Cruisers.

Bids for Scout Cruisers. Gives the bidders and their proposals, with description of the cruisers. 3000 w. Marine Rev—April 20, 1905. No. 69091.

The New Armored Cruiser Washington. Illustrated description of this new vessel, recently launched at Camden, N. J. 1600 w. Naut Gaz—March 30, 1905. No. 68762.

Electric Power.

Electricity as Motive Power for 1,100-Ton Cargo-Boat. J. W. H. Hamilton. Interesting facts relating to the "Vandal," a Russian boat for transportation of oil. Also of a second boat of different design for the same service. 1800 w. Elec Wld & Engr—April 15, 1905. No. 68962.

Exploration Vessel.

The "Discovery." W. E. Smith. Read before the Inst. of Naval Archts. A record of the special features in the design of this Antarctic exploration vessel, describing details of construction. Ills. 8500 w. Engng—April 14, 1905. No. 69236 A.

Launch.

Launch of the Steamship La Provence (Lancement du Paquebot La Provence). A. Dumas. Illustrated description of the launching of a new vessel for the French Transatlantic Line. Displacement 19,160 tons; 30,000 h. p. 1800 w. Génie Civil—March 25, 1905. No. 69116 D.

Motor Boats.

Monaco Motor Boat Meeting. A list of the entered boats, with their characteristics and racing numbers, with illustrated account of the races. 2000 w. Auto Jour—April 15, 1905. No. 69223 A.

The Automobile Boat Hilda. L. Ramakers. Illustrated detailed description of a boat designed for use in the study of the application of internal combustion motors to the propulsion of rapid boats. 1000 w. Marine Engng—April, 1905. No. 68779 C.

The Deep-Sea Cruiser, "Napier Major." Illustrated detailed description. 1200 w. Auto Jour—April 8, 1905. No. 68976 A.

Propeller Shaft.

Repairing a Propeller Shaft. An illustrated account of the repairs executed at sea to the tail shaft of the steamship Milton. 1800 w. Engr, Lond—April 14, 1905. No. 69241 A.

Shallow-Draft.

Design of a Shallow-Draft Boat Driven by Twin-Turbine Propellers. O. Lienau, in *Schiffbau*. An illustrated article explaining method of designing a vessel with a draft not exceeding 16-inches, having a speed of 13 knots in slack water. 2000 w. Marine Engng—April, 1905. No. 68778 C.

Shipbuilding.

Recent Development of Lake Ship Building. Waldon Fawcett. An illustrated article discussing recent vessels for the lakes, and the change of policy made evident in the four new steel steamers under contract. 2200 w. Marine Engng—April, 1905. No. 68777 C.

Steel Shipbuilding in Hongkong. J. W. Graham. Confined to the actual steel portions of a vessel. Discusses the best methods to adopt with Chinese labor to get desired results. Also a description of a new shipbuilding plant at Hongkong. 7700 w. Far-East Rev—Feb., 1905. No. 68738 D.

Sounding Apparatus.

A Leadless Sounding Apparatus. Dr. Alfred Gradenwitz. Describes an apparatus invented by H. Berggraf, a Norwegian engineer, for determining the depth of water under a vessel and continuously recording it. Ills. 900 w. Sci Am—April 22, 1905. No. 69085.

Steamers.

Side-wheel Passenger Steamer Providence. Illustrated detailed description of a sound steamer to run between Providence and New York. 2900 w. Marine Rev—March 30, 1905. No. 68763.

Steam Turbines.

See Mechanical Engineering, Steam Engineering.

Tugboats.

Modern American Tugboats. Illustrates and describes three fine steel tugboats recently built at Staten Island, N. Y. 1000 w. Naut Gaz—April 20, 1905. No. 69062.

Turbine Liner.

The "Victorian," The First Turbine Atlantic Liner. Brief illustrated description. 900 w. Sci Am—April 8, 1905. No. 68849.

MECHANICAL ENGINEERING

AUTOMOBILES.

Albion.

The 16 H. P. Albion Car. An illustrated detailed description of an interesting car. 900 w. Autocar—April 15, 1905. Serial. 1st part. No. 69225 A.

Balancing.

The Balancing of Petrol Engines. J. C. Crombie. Considers the fundamental principles connected with the balancing of reciprocating engines, showing how far it is possible to balance the different types of motors now in use. Ills. 1800 w. Autocar—April 1, 1905. No. 68900 A.

Classification.

Classes in Competitions and Races. Henry Sturmey. Considers the difficulties of classification, weight versus price, workable classification, and regulations for weighing. 2700 w. Autocar—April 15, 1905. No. 69226 A.

Compound Engine.

The Construction and Working of a Compound Petrol Motor. Edward Butler. Illustrated description of a compound 3-cylinder petrol launch motor made in 1888-9 for the Petrol Cycle Syndicate. 1800 w. Mech Engr—March 25, 1905. No. 68744 A.

Coolers.

Water-Coolers for Motor-Cars. J. S. V. Bickford. An account of experimental investigations giving results at variance with those published by other investigators. 2200 w. Engng—March 31, 1905. No. 68905 A.

Electric Vehicles.

The Future of the Electric Automobile. S. G. Chambers. Abstract of a paper read before the London Automobile Club. Considers the commercial future of the electric carriage in its present form. Thinks the touring car will not be electrically driven, nor the omnibus, nor the hackney cab, but that there still remains a large field. 2000 w. Elec Rev, Lond—March 24, 1905. No. 68750 A.

Exhibition.

Agricultural Hall Show. Illustrates and describes some of the vehicles shown at this London exhibition. 2000 w. Auto Jour—March 25, 1905. Serial. 1st part. No. 68742 A.

Motor Car Show at Islington. A brief review of the more interesting exhibits. 2800 w. Engr, Lond—March 24, 1905. No. 68760 A.

Garages.

Salesrooms and Garages in Paris. Brief illustrated descriptions of showrooms, stores, garages, and their equipment. 4000 w. Automobile—April 15, 1905. Serial. 1st part. No. 68932.

Legislation.

Pennsylvania's New Automobile Law. Full text of compromise automobile license and speed measure passed and signed by Governor Pennypacker on April 19. 1800 w. Automobile—April 22, 1905. No. 69090.

The New British Regulations for the Use of Heavy Motor Vehicles. Gives rules limiting the weight of motor vehicles and fixing the width of tire in proportion to the weight and the wheel diameter. 3000 w. Eng News—April 20, 1905. No. 69078.

Omnibuses.

Gasoline Omnibuses in London. An account of the satisfactory service. 2000 w. Automobile—April 15, 1905. No. 68934.

Petrol-Electric.

Krieger Petrol Electric Motor-Car. Illustrated description of a car using a dynamo driven by a petrol motor, without any auxiliary battery for the supply of power. 1500 w. Engng—April 7, 1905. No. 68921 A.

Prunel.

The 1905 Prunel Petrol Cars. An illustrated article describing the new features in this year's models. 1200 w. Auto Jour—April 8, 1905. No. 68977 A.

Reliability Trial.

An Australian Reliability Trial. An illustrated detailed description of the run from Sydney to Melbourne, a distance of 572 miles. 2500 w. Auto Jour—April 15, 1905. No. 69224 A.

Tires.

American Pneumatic Automobile Tires. Illustrates and describes types of tires in use, and the arrangements made to meet the severe conditions; the materials and methods of manufacture are also considered. 3000 w. Automobile—April 15, 1905. No. 68933.

Touring Car.

Stoddard-Dayton Four-Cylinder Touring Car. Illustrated detailed description of a car first shown at the Chicago exhibition. 1800 w. Automobile—April 8. 1905. No. 68875.

Wheels.

Road Wheels for Mechanical Vehicles. R. G. L. Markham. Discusses the conditions necessary for a perfectly satisfactory wheel, illustrating and describing devices under trial. 3800 w. Cassier's Mag—April, 1905. No. 69201 B.

COMBUSTION MOTORS.

Caloric Engine.

Svea Caloric Engine. G. Emil Hesse. An illustrated article explaining the working of this engine. 1400 w. Sci Am Sup—April 29, 1905. No. 69257.

Diesel.

The Diesel Oil Engine. Illustrated description of British-built Diesel engines, with account of their development. 1200 w. Engr, Lond—March 31, 1905. No. 68912 A.

Gas Engines.

500 B. H. P. Gas Driven Dynamo Engine. Illustrated description of a double-acting two-cylinder gas engine of the Cockerill type, recently built for the electric station of Middlesbrough works. 800 w. Engr, Lond—April 7, 1905. No. 68994 A.

Gas Engines for Railway and Power Service. Illustrates and describes the two types of engines developed by the Westinghouse Co. and their operation. 2500 w. St Ry Rev—April 15, 1905. No. 69069 C.

Recent German Gas Engines. Prof. E. Meyer. Read before the Verein Deutscher Eisenhüttenleute. Describes some of the recent large gas engines of German makers. Ills. 1200 w. Am Mfr & Ir Wld—April 6, 1905. No. 68729.

The Koerting Four Cycle Gas Engine. F. E. Matthews. Illustrated description of this engine with report of tests. 1600 w. Cent Sta—April, 1905. No. 68865.

The Mechanical Efficiency and Indicated Capacity of the Gas Engine (Der Mechanische Wirkungsgrad und die Indizierte Leistung der Gasmaschine). An exhaustive symposium, to which contributions are made by Stodola, Riedler, Schöttler, Meyer, Ehrhardt, and Wagener. 10000 w. Zeitschr d Ver Deutscher Ing —April 1, 1905. No. 69112 D.

Gas Power.

Gas Producers in Ironworks. Paper read by Herr Otto Wolff before the Assn. of Ironmasters in S.-W. Germany, at Saarbrucken. Explains the principle of gas producers, the requirements of a good producer, and discusses various forms that have stood the test of practical working. Ills. 3000 w. Ir & Coal Trds Rev—April 14, 1905. No. 69242 A.

Power Generation at Coal Mines in Connection with Coke Ovens (Krafterzeugung auf Kohlengruben im Anschluss an Koksöfen). H. Iffland. An examination of the cost of power generated at the mine, including the use of coke-oven gases in gas engines. 3000 w. Glückauf—March 25, 1905. No. 69131 B.

Power Production from Gaseous Fuel. J. R. Bibbins. Read before the Ohio Gas Lgt. Assn. Considers producer gas is to furnish the solution to the power problem, and gives much information in regard to applications. Discussion. 7500 w. Pro Age—April 15, 1905. No. 68914.

Oil Engines.

Some Features in the Design of Oil Engines. Edward Butler. The present article considers engines working with an exhaust heated vaporizer. *1200 w. Mech Engr—April 8, 1905. Serial. 1st part. No. 68982 A.

The Hornsby Vertical Oil-Engine. Illustrated detailed description, with summaries of trials. 1400 w. Engng—March 31, 1905. No. 68908 A.

Suction Gas.

Suction-Gas Plants. F. H. Bowman. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Discusses points to be considered in determining the nature of the plant to be used; the principal forms of producers, especially suction-gas producers. Discussion. 4500 w. Elect'n, Lond—April 7, 1905. No. 68988 A.

Suction Gas Producers. The present article discusses the advantages claimed for the suction producer, the types now on the market, some applications, &c. 2700 w. Engr, Lond—March 31, 1905. Serial. 1st part. No. 68910 A.

The Design and Operation of the Suction Gas Producer. Rodolphe Mathot. A practical discussion of the design and best proportions of suction gas producer plants, showing the high efficiency of the apparatus. 3000 w. Engineering Magazine—May, 1905. No. 69172 B.

Waste Gas.

Electric Smelting and Blast Furnace Gases. Auguste J. Rossi. The first part of an article on the utilization of blast furnace gases for the generation of electrical energy for use in the electric furnace. 2000 w. Elec-Chem & Met Ind—April, 1905. Serial. 1st part. No. 68776 C.

The Use of Waste Gases in Gas Engines. Max Rotter. Abstract of an address before the Steel Works Club of Joliet, Ill. Considers briefly coke oven gas, blast furnace gas, governing, &c. 2000 w. Engr, U S A—April 15, 1905. No. 68997 C.

HEATING AND COOLING.

Hot-Air.

Gas as a Fuel for Hot-Air Heating. R. S. Thompson. Read before the Am. Soc. of Heat. & Ven. Engrs. Considers how to use gas successfully and economically in hot-air heating. 2800 w. Can Archt—March, 1905. No. 68740 C.

Hot Water.

Charts for the Steam Fitter. Piping for Hot Water Heating. William G. Snow. The first of a series of charts on piping erection for hot-water and steam systems, with explanatory notes. 300 w. Met Work—April 29, 1905. Serial. 1st part. No. 69272.

N. Y. Stock Exchange.

Heating, Ventilating and Air Cooling at the New York Stock Exchange. Illustrated description of the interesting engineering equipment of this fine building. 2300 w. Eng Rec—April 8, 1905. Serial. 1st part. No. 68896.

Refrigeration.

Electric Power for Refrigeration. J. C. Chamberlain. Illustrated description of an automatic refrigerating plant and its operation. 1700 w. Elec Wld & Engr —April 1, 1905. No. 68807.

HYDRAULICS.

Centrifugal Pumps.

Phenomena of Machine Operation. John Richards. Considers the evolution of apparatus to impel fluids, especially liquids, by centrifugal force, as illustrated by centrifugal pumping turbines, &c., showing that development has often been by studying the conditions of use. 3300 w. Jour Assn of Engng Socs—March, 1905. No. 69048 C.

Hydro-Electric Stations.

See Electrical Engineering. Generating Stations.

Pumping.

See Civil Engineering, Water Supply.

Pumps.

Pump Piping. W. H. Smead. Describes some of the most practical ways of connecting pumps. Ills. 1200 w. Engr, U S A—April 1, 1905. Serial. 1st part. No. 68804 C.

Regulation.

A System of Regulating Centrifugal Fans and Pumps. Aegidius Elling. An illustrated article explaining the system of regulation, and a contrivance for removing the worst drawbacks. 2000 w. Prac Engr—April 7, 1905. Serial. 1st part. No. 68978 A.

Stream Discharge.

See Civil Engineering, Measurement.

Stream Power.

Power Capacity of a Running Stream Without Storage. William G. Raymond. From Pro. of the Iowa Engng. Soc. Shows that for streams on which there is little or no storage, the only proper way to estimate the power available is to estimate it from the daily rather than the monthly flow. 2800 w. Elec Rev, N Y—April 8, 1905. No. 68884.

Valves.

Free Moving Pump Valves (Ueber Freigehende Pumpenventile). L. Klein. Data and results of experimental investigations into the relation of lift to discharge in the case of pump valves free from any mechanical control. 1800 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69108 D.

MACHINE WORKS AND FOUNDRIES.

Car Wheels.

The New Car-Wheel Foundry of the Pennsylvania R. R. Illustrated detailed description of this new shop at Altoona, Pa., and its equipment. 3000 w. Eng Rec—April 8, 1905. No. 68891.

Case-Hardening.

Case-Hardening. David Flather. Read before the Cycle Engineers' Inst., Birmingham, Eng. An illustrated article describing the process and the equipment and materials needed. 6000 w. Ir & Steel Mag—April, 1905. No. 69049 D.

Castings.

A Jet Condenser Casting and the Pattern Work for It. Joseph Horner. Illustrated description of patterns and methods used. 1200 w. Am Mach—April 13, 1905. No. 68927.

Making Fine-Surfaced Castings. Walter J. May. Suggestions for obtaining good results. 1500 w. Prac Engr—April 14, 1905. No. 69227 A.

Mending a Casting with Thermit. Patrick Redington. Facts from the writer's experience. 1000 w. Foundry—April, 1905. No. 69018.

Chemistry.

Chemistry in Foundry Practice. N. W. Shed. Read before the Buffalo Found. Assn. On the change in methods brought about by the chemist, and his value, especially in the making of special irons. 1700 w. Foundry—April, 1905. No. 69016.

Science in the Iron Foundry. J. E. Stead. Calls attention to certain necessary conditions for carrying out foundry practice in the present, suggesting lines metallurgical chemists should follow. 5000 w. Ir & Steel Mag—April, 1905. No. 69050 D.

Cores.

Core Room Records. R. W. McDowell. On the importance of keeping accurate cost records for core rooms, explaining a method of keeping records of a radiator plant. 2000 w. Foundry—April, 1905. No. 69017.

Core Sand Binders. J. S. Robeson. Read before the Pittsburg Found. Assn. Considers the work required of a binder, the usual methods of preparing the mixture, and matters related. 4000 w. Foundry—April, 1905. No. 69015.

Cost Keeping.

See Industrial Economy.

Elbow.

Developing a Cylinder Intersecting an Elbow by the Method of Projection. Illustrates and describes the method used in developing the pattern. 1000 w. Boiler Maker—April, 1905. No. 68869.

Electric Driving.

Some Special Applications of Electric Driving (Ueber Einige Elektrische Spezialantriebe). Alfred Kolben. Describing the electric driving of centrifugal sugar separators, of textile machinery, color presses, etc. 4000 w. Zeitschr f Elektrotechnik—April 2, 1905. No. 69155 D.

Systems of Electrical Distribution in Railway Shops. J. Henry Klinck. An illustrated article discussing the system best adapted to railroad repair work. 4500 w. Ry Mas Mech—April, 1905. No. 68872.

The Attachment of Motors to Machine Tools. Illustrates and describes the methods of the Crocker-Wheeler Company. 2800 w. Am Mach—Vol. 28, No. 17. No. 69245.

Flanging.

A Large Cold Flanging Machine. E. A. Suverrop. Illustrated description of a Rochester, N. Y., plant for the manufacture of glass-lined steel tanks. 3000 w. Am Mach—Vol. 28, No. 14. No. 68796.

Lovekin's Pipe-Flanging Machine. Illustrates and describes machinery and tools for putting flanges on copper pipes by means of expansion, in such a way as to make a tight joint, without any brazing. Also applicable to wrought iron or steel pipe. 1800 w. Engng—March 24, 1905. No. 68755 A.

Foundry.

Iron Foundry of the Yale & Towne Mfg. Co., Stamford, Conn. Illustrated article describing a foundry where the entire output is high grade small work. 1000 w. Foundry—April, 1905. No. 69014.

Grinding.

Grinding and Grinding-Machine Rests. Illustrates and describes rests in use, which the writer commends as the best he has seen. 1600 w. Am Mach—Vol. 28, No. 16. No. 69074.

Hardening.

The Brayshaw Salt Bath Hardening Furnace. Emile Guarini. Illustrated description of a furnace designed to effect the hardening of steel articles with a degree of precision hitherto unattained. 1000 w. Ir Age—April 20, 1905. No. 69004.

Hoppers.

A Trough Hopper Intersecting a Truncated Cone. Illustrates and describes the method used. 700 w. Boiler Maker—March, 1905. No. 68866.

Japan.

The Manufacture of Electrical Machinery in Japan. William Dinwiddie. Illustrates and describes the Shibaura Engineering Works and some of their products. Also editorial on the quality and cost. 2800 w. Elec Rev, N Y—April 22, 1905. No. 69095.

Krupp.

The Krupp Works. Emile Guarini. Brief illustrated descriptions of the Krupp establishments in Germany, which consist of eight different groups, and employ nearly 150,000 people. 2800 w. Cassier's Mag—April, 1905. No. 69200 B.

Lathes.

A Rapid Production Vertical Turret Lathe. Illustrated description of a new machine for handling heavy face-plate work of all descriptions. 800 w. Ry Mas Mech—April, 1905. No. 68873.

The Automobile Versus the Hand Turret Lathe. P. V. Vernon. A reply to an article by Paul Wesley, followed by an illustrated description of the operation of the automatic machine. 2000 w. Am Mach—Vol. 28, No. 16. No. 69072.

3-In. Flat Turret Lathe with Cross-Sliding Head. Illustrated detailed description. 900 w. Engng—March 31, 1905. No. 68907 A.

Lead Pipes.

The Relative Values of Hydraulic-Drawn and Hand-Made Lead Pipes and Traps. Thomas Daye. Considers the advantages of lead over iron pipes, and the processes of making the drawn and hand-made pipes, concluding that the latter are more likely to be free of impurities, but should be made without a soldered seam. 3500 w. Plumb & Dec—April 1, 1905. No. 68898 A.

Liquid Fuel.

Liquid Fuel for Furnace Equipment. W. N. Best. On the increasing use of liquid fuel and its success in forges and furnaces. 1600 w. Sci Am—April 8, 1905. No. 68850.

Machine Tools.

Machine Tool Design. Prof. J. T. Nicholson, and Dempster Smith. The first of a series of articles offering a new series of rules of design, based upon extensive experiments on cutting with the new steels, and checked by numerical data collected from the most recent practice of machine tool makers. 3300 w. Engr, Lond—April 7, 1905. Serial. 1st part. No. 68992 A.

Proportions of Machine Tool Parts. Thomas R. Shaw. Tables and figures. Mech Engr—April 8, 1905. Serial. 1st part. No. 68980 A.

Melting.

The Melting and Cooling of Foundry Iron. Abstract of an address delivered by R. Buchanan before the Coventry (England) Engineering Society. 1200 w. Am Mach—Vol. 28, No. 13. No. 68787.

Molding.

Molding a Jet Condenser. Joseph Horner. Illustrates and describes the method used. 800 w. Am Mach—Vol. 28, No. 16. No. 69073.

Punching.

Punching Small Holes in Tool Steel Blanks. Joseph V. Woodworth. Illustrates and describes tools used for punching holes 0.050 inch in diameter through steel 1-16 inch thick. 700 w. Mach, N Y—April, 1905. No. 68808 C.

Shop Appliances.

Mechanical Appliances in Iron Works (Maschinelle Einrichtungen für das Eisenhüttenwesen). Fr. Frölich. The first article discusses devices used in connection with the rolling and drawing of tubing. Serial. Part I. 2000 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69104 D.

Shop Tools and Devices. F. J. Le Card. Illustrated Sketches of tools and appliances useful for purposes stated. 700 w. Am Mach—Vol. 28, No. 15. Serial. 1st part. No. 68925.

Shops.

The New Works of the Ingersoll-Sergeant Drill Company. Illustrated description of extensive shops at Phillipsburg, N. J., for making air-compressors, rock-drills, and coal-cutters. 3800 w. Eng Rec—April 15, 1905. Serial. 1st part. No. 68967.

The Shops of the United Shoe Machinery Co., Beverly, Mass. Illustrated detailed description of shops for the manufacture of light machinery. 2700 w. Eng Rec—April 1, 1905. Serial. 1st part. No. 68826.

Soldering.

How to Make an Electric Soldering Iron. Arthur B. Weeks. Directions, with design, and remarks on its use. 1000 w. Sci Am—April 8, 1905. No. 68851.

Time System.

A Decimal Time System for Factories. Illustrates and describes some devices for time keeping. 1200 w. Am Mach—Vol. 28, No. 16. No. 69071.

Tool Works.

The Plant of the Ridgway Machine Tool Company. Illustrated detailed description of new works at Ridgway, Pa., for the building of high class heavy machine tools. 3500 w. Ir Age—March 30, 1905. No. 68790.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Notes on Engineering Alloys. Ernest A. Lewis. A discussion of alloys used in brass-foundries, giving general rules for the production of good castings. 2200 w. Engng—March 31, 1905. No. 68906 A.

Brittleness.

The Influence of the Form of Test Piece upon Tests for Brittleness (Influence des Variations de Forme de l'Entaille dans les Essais de Fragilité). F. Barbier. Discussing especially the effect of the shape of the notch upon drop tests on notched bars. 1200 w. Génie Civil—April 1, 1905. No. 69118 D.

Low Temperatures.

The Effect of Liquid Air Temperatures on the Mechanical and Other Properties of Iron and Its Alloys. Sir James Dewar, and Robert Asholt Hadfield. Gives the more important results of a series of tests carried out on some five-hundred specimens of standard iron and iron alloyed with other elements. 4200 w. Sci Am Sup—April 15, 1905. No. 68938.

Patina.

Patina and Its Chemistry. Dr. Otto N. Witt. Showing that rusting and the formation of patina are closely related from the chemist's point of view, and both are caused by the condition of the atmosphere. 2700 w. Sci Am Sup—April 22, 1905. No. 69086.

Testing.

Method of Making Tests on Metals. Dr. A. Gradenwitz. Illustrated description of apparatus, described by M. Guillery in a recent paper for carrying out mechanical tests on metals. 1400 w. Ir Trd Rev—April 6, 1905. No. 68781.

Tool Steel.

The Uses of High-Speed Steel. Remarks on methods of using, treating and grinding high-speed steel. 2000 w. Mach, N Y—April 1, 1905. No. 68809 C.

MEASUREMENT.

Dynamometers.

The Use of Dynamometers. N. Ronneberg. An illustrated description of the manner of using these instruments for measuring power. 2000 w. Mod Mach April, 1905. No. 68734.

Friction.

The Laws of Sliding Friction (Sur les Lois du Frottement de Glissement). Paul Painlevé. An examination of the laws of Coulomb, showing the influence of the distribution of the pressure upon the friction of two surfaces. 2000 w. Comptes Rendus—March 13, 1905. No. 69122 D.

Gunnery.

A Practical Method of Adjusting a Modern Gun and Determining Its Errors and the Errors of Its Telescopic Sight. Otto von Geldern. Treats the gun in the sense of a mathematical instrument only, and explains a method by which it may be oriented and adjusted, and by which any error in its horizontal or vertical motion may be detected. 4000 w. Eng News—April 13, 1905. No. 68949.

Indicator Springs.

Indicator Springs Subjected to Tension (Auf Zug Beanspruchte Indikatorfedern). R. Schwirkus. Tabulated results of tests on indicator springs made at the Reichsanstalt, showing that there is less trouble from lateral bending with the tension springs than with those under compression. 1800 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69109 D.

Metric System.

The Metric Fallacy. Frederick A. Halsey. An explanation of the difficulties arising in displacing a system of weights and measures, and why scientific men regard the subject differently than manufacturers. 8500 w. Sib Jour of Engng—April, 1905. No. 69040 C.

Torsion Meter.

Denny and Johnson's Torsion Meter. Illustrated detailed description of instruments by use of which the torsion of revolving shafts may be ascertained, enabling the h. p. transmitted to be accurately calculated. 2500 w. Engng—April 7, 1905. No. 68918 A.

POWER AND TRANSMISSION.

Compressed Air.

Hydraulic Compressed Air in Connecticut. J. Herbert Shedd. Briefly reviews the early uses of compressed air and describes some of the features of an installation for the hydraulic compression of air of a plant in Connecticut. Ills. Discussion. 7000 w. Jour N Eng W-Wks Assn—March, 1905. No. 69052 F.

Cranes.

Electric Crane at the St. Triphon Quarries, Switzerland. C. L. Durand. Illustrates and describes the new electric lifting and conveying apparatus and its working. 1100 w. Elec Rev, N Y—April 1, 1905. No. 68788.

Elevators.

Electrically-Driven Lifts. F. O. Hunt. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. An illustrated article discussing features needing to be improved, and the most suitable type of motor. 1800 w. Elec Engr, Lond—April 7, 1905. Serial. 1st part. No. 68985 A.

Investigations of the Operation of Electric Elevators (Untersuchung des Auslaufweges Elektrischer Aufzüge). Hugo Stahl. With diagrams showing the accelerations, and general action, with various methods of braking and control. 4500 w. Zeitschr d Ver Deutscher Ing—April 8, 1905. No. 69113 D.

Gearing.

A Spur-Gear Anglemeter. W. M. Wilson. An illustrated descripton of an instrument designed for determining the variation in the angular velocity ratio of gears, explaining its use. 3000 w. Am Mach—Vol. 28, No. 15. No. 68924.

Bevel Gear Formulas. John Edgar. A compilation of a set of formulas that will answer for any case. 1300 w. Am Mach —Vol. 28, No. 15. No. 68926.

Motor Springs.

The Motor Spring and Its Calculation. Emil Riedel. Translated from *Allgemeine Uhrmacher Zeitung.* An explanation of the essential and ruling features of so-called mainsprings. 1700 w. Sci Am Sup—April 22, 1905. No. 69087.

Shafts.

Strength of Shafts and Pins. George A. Lister. Gives formulas and diagrams, explaining method of ascertaining size to fulfil any given conditions. 500 w. Mech Engr—March 18, 1905. No. 68743 A.

STEAM ENGINEERING.

Accidents.

Accidents to Boilers and Engines (Schäden an Dampfkesseln und Maschinen). Notes concerning some recent boiler explosions in Germany, and an illustration of the disastrous effects of a flywheel explosion. 1200 w. Glückauf—March 25, 1905. No. 69132 B.

Boiler Bracing.

Bracing Flat Surfaces. William Horsley. Gives table showing the number of braces required on each head on return tubular boilers, with explanatory notes. 500 w. Boiler Maker—April, 1905. No. 68870.

Boilers.

The Care and Management of Steam Boilers. W. H. Fowler. An illustrated review of the mechanical stokers of various types, discussing their merits. 3000 w. Mech Engr—April 1, 1905. Serial. 1st part. No. 68901 A.

Types of Shell Boilers. R. S. Rodie. Drawing and description of a marine shell boiler of the flue and return tubular type. 1500 w. Boiler Maker—March, 1905. Serial. 1st part. No. 68868.

Clearance.

The Effect of Clearance and Compression of Steam Consumption. C. H. Benjamin. Reviews the results of various experimental investigations. 1200 w. Engr, U S A—April 15, 1905. No. 68996 C.

Coal Testing.

Testing Coals and Lignites at the St. Louis World's Fair. E. W. Parker. Mr. Parker's second paper discusses the tests upon lignites, and the gas-producer and briquetting tests, with numerous important tables. 4500 w. Engineering Magazine—May, 1905. No. 69174 B.

The Advantage of a Scientific Basis for Determining the Value of Fuels. Henry J. Williams. Showing the value of analysis and the calorimeter test, offering suggestions for sampling, and describing a calorimeter perfected by the writer. Also discussion. Ills. 9500 w. Jour N Eng W-Wks Assn—March, 1905. No. 69059 F.

The Calorimetric Testing of Coal. George T. Hanchett. Describes method of conducting a test with very simple apparatus. 2500 w. Am Elect'n—April, 1905. No. 68814.

Corliss Engine.

An Old Corliss Engine. Illustrations, with description, of an engine built in 1851 and erected in 1857, which is still in service and likely to continue working for many years more. 1000 w. Power—April 1, 1905. No. 68793 C.

Fire-Boxes.

To Develop Pattern Sheets for Radial Stayed Fire-Boxes. R. C. Young. Directions for developing the pattern. Ills. 1100 w. Boiler Maker—March, 1905. No. 68867.

Fly Wheels.

The Graphical Determination of Flywheel Weights (Die Graphische Ermittlung des Schwungradgewichtes). F. Wittenbauer. A study in graphical dynamics, showing the method of plotting the varying forces in such a way as to enable the regulating weight to be determined. 4000 w. Zeischr d Ver Deutscher Ing—March 25, 1905. No. 69105 D.

Fuel.

Fuel and Furnaces. Abstracted from *Steam: Its Generation and Use*, published by Babcock and Wilcox, Ltd. Deals from a theoretical point of view, with the utilization of the various kinds of fuel and the form of furnace best suited for their combustion. 1700 w. Col Guard (Sup)—March 31, 1905. Serial. 1st part. No. 68904 A.

Steam Engines.

First Report to the Steam Engine Research Committee. Prof. David S. Capper. Giving results of experiments at King's College, London, on jacketed and unjacketed cylinders. 13300 w. Diagrams. Inst of Mech Engrs—March 17, 1905. No. 68752 D.

Modern Continental Steam Engines. L. Ramakers. Illustrates and describes engines on the Lenz system. 1500 w. Prac Engr—April 7, 1905. No. 68079 A.

Steam Pipes.

The Arrangement of Steam Pipes. R. T. Strohm. Illustrates and describes methods of providing for expansion and contraction. 2000 w. Am Elect'n—April, 1905. No. 68811.

Steam Turbines.

Computation Tables for Steam Turbines (Abstufungstafel für Dampfturbinen). Donat Banki. A discussion of the determination of the best number of stages to be used in a multistage turbine for any given pressure drop. 2000 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69106 D.

Mechanical Construction of Steam Turbines and Turbo-Generators. W. J. A. London. Abstract of a paper read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. Deals with the difficulties met in the successful design of steam turbine machinery. Ills. 5000 w. Elect'n, Lond—March 24, 1905. No. 68751 A.

Multiple Steam Turbines. H. Melencovich. Read before the Inst. of Engrs. & Shipbuilders. On the method of reducing high revolutions and circumferential velocities of steam turbines by passing the steam through a number of turbine wheels arranged in series. 3000 w. Mech Engr—April 8, 1905. No. 68981 A.

Steam Turbine Power Plant at a Poughkeepsie Shop. Illustrated description of a plant furnishing the power and lighting to the works of the De Laval Separator Co., showing space economy, an interesting system of steam piping, and other unusual features. 2500 w. Eng Rec—April 22, 1905. No. 69214.

The Steam Turbine Power Station at St. Ouen (Das Dampfturbinen Kraftwerk St. Ouen). Ludwig Troske. A very complete account of one of the power houses on the Paris Metropolitain, in which steam-turbine generating sets are used exclusively. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—April 1, 8, 1905. No. 69111 each D.

Turbines vs. Reciprocating Engines in Marine Service. Discusses the comparative results of the two methods, as shown by the "King Edward" and "Queen Alexandra." 1200 w. Sci Am—April 8, 1905. No. 68818.

Working Results of a Steam Turbine Plant. Gives interesting figures relating to the turbine plant at the new Neepsend generating station of the Sheffield Corporation. 600 w. Mech Engr—March 25, 1905. No. 68747 A.

Superheating.

Superheated Steam. A. G. Gibson. Read before the Owens College Engng. Soc. Briefly reviews the history of superheating, and considers superheating as applied to steam engines or steam turbines. 3700 w. Mech Engr—March 25, 1905. Serial. 1st part. No. 68746 A.

Superheated Steam in Pumping Engines. E. H. Foster. Reviews the results of various tests made, and gives information of interest showing the advantages of superheating. Ills. 3500 w. Jour N Eng W-Wks Assn—March, 1905. No. 69058 F.

The Promise of Superheaters. Editorial discussing steam superheaters for locomotives. 1700 w. Ry & Loc Engng—April, 1905. No. 68785 C.

The Transfer of Heat in the Heizmann Superheater (Wärmedurchgangsversuche mit dem Dampfüberhitzer von Heizmann). Dr. Otto Berner. Data and results of experimental tests of the transfer of heat in superheaters, both in the smoke flue and when independently fired. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—March 25, April 8, 1905. No. 69103 each D.

Vacuum.

High Vacuum Condensing Plants. Ernest Kilburn Scott. Discusses condensers arranged on what is known as the contra flow principle. 1200 w. Aust Min Stand—March 22, 1905. No. 69220 B.

The Effect of Vacuum on Steam-Engine Economy. R. M. Neilson. The first of two articles, discussing the important influence of vacuum upon the economical performance of steam engines and steam turbines. 3500 w. Engineering Magazine—May, 1905. No. 69175 B.

Valve Gear.

Studies in the Heusinger Valve Gear (Untersuchungen an der Heusinger Steuerung). W. Pfitzner. An examination of the so-called Heusinger, or Walschaert type of radial valve gear, extensively used on Continental locomotives. 2000 w. Zeitschr d Ver Deutscher Ing—March 25, 1905. No. 69107 D.

Waste Steam.

Utilizing Waste Steam in Shops. Illustrated description of the method adopted in the Grand Trunk shops, in Montreal. 1300 w. Ir Age—April 27, 1905. No. 69244.

Water Softening.

Notes on Softening and Purification of Water for Steam Raising. Louis J. Le Clair. Read before the Dublin Loc. Sec. of Inst. of Elec. Engrs. On methods of treatment for the softening and the purification of boiler water. 3500 w. Elec Engr, Lond—April 21, 1905. No. 69328 A.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

The Technical Analysis of Mineral Coal. Dr. J. Ohly. Describes methods in making the determinations. 2000 w. Min Rept—April 6, 1905. No. 68878.

Anzin.

The Anzin Mining Company and its New Arenberg Shaft (Die Bergwerksgesellschaft Anzin und Ihre Neue Schachtanlage Arenberg). An account of the recent developments of one of the oldest and most important coal mining districts of France. 4000 w. Glückauf—April 8, 1905. No. 69135 B.

Bituminous.

Bituminous Coal Washing. L. A. Harding and G. R. Delamater. Illustrated article describing various methods employed. 4300 w. Mines & Min—April, 1905. Serial. 1st part. No. 68863 C.

Briquettes.

Briquetting Fuel. George E. Walsh. An account of this industry in Europe and America. Min Rept—April 13, 1905. No. 68959.

Coal Basin.

The Coal Basin of the Meurthe-et-Moselle (Le Bassin Houiller de Meurthe-et-Moselle). Describing the conclusions drawn from borings in Lorraine, showing the extensive deposits of coal at depths of 250 to 600 metres. 2500 w. Génie Civil—April 8, 1905. No. 69120 D.

The Coal Explorations in Meurthe-et-Moselle (Sur les Recherches de Houille en Meurthe-et-Moselle). R. Nicklès. An account of the borings at Eply, Lesménils and Pont-à-Mousson, in the department of Meurthe-et-Moselle, resulting in the discovery of a workable coal basin. 1200 w. Comptes Rendus—March 27, 1905. No. 69125 D.

The Discovery of Coal in Meurthe-et-Moselle (Sur la Découverte de la Houille en Meurthe-et-Moselle). C. Cavallier. An account of the successful borings in the vicinity of Pont-à-Mousson, with a description of the geology of the district. 1000 w. Comptes Rendus—March 27, 1905. No. 69124 D.

Coal Lands.

The Coal Mines on the West Side Belt Railroad. Samuel Sanford. An illustrated account of these coal lands near Pittsburg, and their development. 4700 w. Eng & Min Jour—April 6, 1905. No. 68799.

Coal Testing.

See Mechanical Engineering, Steam Engineering.

Coke.

A Coking Coal in Chihuahua. William B. Phillips. Describes this seam of coking coal, giving information of its coking quality. 900 w. Eng & Min Jour—April 6, 1905. No. 68802.

Coke Ovens.

Electrically-Served Semet-Solvay Coke Plant at the Works of the Wigan Coal & Iron Company, Limited. Illustrates and describes a battery of forty-four coke ovens installed to secure a more economical supply of coke for use in the blast furnaces of this company. 2500 w. Ir & Coal Trds Rev—April 7, 1905. No. 68990 A.

Colorado.

Disturbances and Other Peculiarities of the Northeastern Coal Field of Colorado Between Ralston Creek and Boulder. A. Lakes. Illustrated description of the geology of these coal-fields, unusually complicated by folds and faults. 1800 w. Min Rept—March 30, 1905. No. 68771.

The Grand River Coal Field. A. Lakes. Describes this largest field in Colorado, which contains a greater variety of coals than any other in the State. Ills. 1300 w. Min Rept—April 13, 1905. No. 68961.

The Yampa Coal Field of Routt County, Colorado. A. Lakes. Brief description of this field which contains the largest area of workable anthracite known in the State. Ills. 900 w. Min Rept—April 20, 1905. No. 69097.

Conveying.

A New Coal-Loading Plant at Lorain, O. An illustrated description of a coal shipping plant, explaining the conditions to be met. 1500 w. Eng News—April 20, 1905. No. 69079.

Mechanical Coal Conveying at the Face. Abstract of a paper by H. Palmer, *Jour. Brit. Soc. of Min. Students.* Illustrated notes on the construction and management of an underground conveying system, patented by W. C. Blackett. 1300 w. Col Guard—April 7, 1905. No. 68915 A.

Peat.

Peat Fuel Works at Chelsea, Mich. D. Bennett. An illustrated description of the methods used in preparing the peat for market. 700 w. Engr, U S A—April 1, 1905. No. 68803 C.

Preparation Plant.

The Electrically-Driven Preparation Plant of the Dalbusch Mines (Untersuchung der Elektrisch Betriebenen Aufbereitungs-Anlagen auf Zeche Dahlbusch III-IV-VI). A general account of the results of tests of an electrically-driven coal cleaning and washing plant, with tables and diagrams showing power consumption. 6000 w. Glückauf—March 31, 1905. No. 69133 B.

Washington.

Mt. Rainier Coalfields. George S. Rice. Information concerning those fields especially interested in the coast trade and tributary to the ports of Seattle and Tacoma. 1500 w. Eng & Min Jour—April 6, 1905. No. 68801.

COPPER.

Arizona.

The Globe District of Arizona. Brief illustrated description of an interesting copper district. 800 w. Min & Sci Pr—April 15, 1905. No. 69204.

Cyanidation.

Ammonia Cyanidation of Copper. A. Jarman and E. Le Gay Brereton. Abstract from Pro. of the Inst. of Min. & Met. Describes experiments made with the object of finding some solvent possessing a more highly selective action for gold in the presence of copper carbonate that is possessed by potassium cyanide itself. Gives conclusions. 2200 w. Eng & Min Jour—April 27, 1905. No. 69265.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Japan.

The Besshi Copper Mine, Shikoku, Japan. C. J. Davidson. From a report to the Foreign Office. Gives the location, geological formation, description of mine, methods, ore handling, and reduction works in the present number. 3500 w. Min Jour—April 15, 1905. Serial. 1st part. No. 69222 A.

Mexico.

The Mines of Cananea, Mexico. An illustrated description of these mines, chiefly valuable for copper. 1000 w. Min & Sci Pr—April 1, 1905. Serial. 1st part. No. 68879.

Smelting.

Metallurgy of Copper. Horace J. Stephens. An interesting discussion of the methods of copper refining. 5500 w. Ores & Metal—April 15, 1905. No. 68989.

Wyoming.

Blister Copper, 99 Per Cent. Pure. C. R. Stegemann. An illustrated account of the Ferris-Haggarty mine, and its operation. 1500 w. Min Wld—April 15, 1905. No. 68957.

GOLD AND SILVER.

Arizona.

The Tombstone District of Arizona. An illustrated account of this region, describing the deposits carrying values in gold. 2800 w. Min & Sci Pr—March 25, 1905. No. 68770.

Bohemia.

The Mine Workings at Katharinaberg in Bohemia (Der Erzbergbau zu Böhmisch-Katharinaberg im Erzgebirge). Viktor Zeleny. A general account of the geology of the district, lying between the frontiers of Bohemia and Saxony. The ore is a copper glance containing silver. Two articles. 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 18, 25, 1905. No. 69137 each D.

Concentrates.

Treating Concentrates by Pan Amalgamation at the Minas del Tajo, Mexico. A. E. Drucker. Describes a process for working fresh or oxidized concentrates. 2700 w. Min & Sci Pr—April 15, 1905. No. 69205.

Concentration.

Notes on Concentrating Mills. Alfred Harvey. Illustrates and describes a typical arrangement of samplers, crushing, and sizing machinery in a modern gold and silver concentrating mill. 1800 w. Mines & Min—April, 1905. No. 68826 C.

Cyanide.

Cyanidation in the South. Herbert A. Megraw. Describes the installation at the Iola mine in North Carolina, and the application of the process used to Southern low-grade ores. Ills. 2200 w. Eng & Min Jour—April 13, 1905. No. 68930.

Dredging.

Dredges for Working Gold-Bearing Gravels. Illustrated description of a dredge recently built for use in California, with some account of this method of working. 1700 w. Eng News—April 27, 1905. No. 69249.

Gold Dredging in Oroville District, Cal. L. J. Hohl. Abstract from the Trans. Cal. Min. Assn. An account of this method of working auriferous gravel deposits, giving illustrated description of dredgers and general features of different types. 3000 w. Min & Sci Pr—April 15, 1905. Serial. 1st part. No. 69203.

Recent Dredging Practice in Australia and New Zealand. H. L. Lewis. The present article considers buckets v. pumps in dredging, and hints on prospecting. 2800 w. Min Jour—April 1, 1905. Serial. 1st part. No. 68903 A.

Ecuador.

Mining in Ecuador. Harry O. Robinson. Information in regard to the development of mining. The values of the ores are mostly in gold. 2000 w. Min Wld—April 1, 1905. No. 68737.

Mexico.

Rich Old Mines of Sonora. E. F. Nichols. Information of interest relating to these old mines yielding gold, silver, quicksilver and other ores. Map. 3200 w. Min Wld—April 1, 1905. No. 68736.

The Sahuayacan District, Mexico. Rufus M. Bagg, Jr. An illustrated article describing the gold and silver mines of the region. 1400 w. Eng & Min Jour—April 20, 1905. No. 69064.

Nevada.

The Walker River District, Nevada. Dwight T. Smith. Describes the ore deposits which carry copper and gold, the geology, &c. 1800 w. Min & Sci Pr—March 25, 1905. No. 68768.

Ore Deposits.

The Yankee Girl Orebody. T. E. Schwarz. Illustrated description of the deposits of silver and copper at Red Mountain, near Ouray, Colorado, discussing the interesting features. 1100 w. Eng & Min Jour—April 27, 1905. No. 69264.

Precipitation.

Precipitation of Gold from Cyanide Solutions. W. J. Sharwood. Abstract of a paper read before the California Miners' Assn. Briefly describes different methods of precipitation in use, discussing results. 2500 w. Eng & Min Jour—April 20, 1905. No. 69065.

Queensland.

Gold, Platinum, Tinstone and Monazite in the Beach Sands on the South Coast of Queensland. Lionel C. Ball. With appendices on the beach sands of New South Wales, and the physical properties, sources, and uses of platinum. Ills. 5700 w. Queens Gov Min Jour—Feb. 15, 1905. No. 68741 B.

Mount Morgan Gold Mine (Q.). E. J. Dunn. Read at meeting of the Royal Society of Victoria. The present article describes the structure of the mine. 2000 w. Aust Min Stand—March 22, 1905. Serial. 1st part. No. 69219 B.

South Africa.

South African Methods. Thomas H. Leggett. Abstract of an address before the California Miners' Assn. On the methods of mining, especially the deep-level properties ,labor, costs, &c. 2700 w. Eng & Min Jour—April 20, 1905. No 69066.

South Dakota.

The Metallurgical Practice in the Black Hills, South Dakota. Charles H. Fulton. Describes the development of the processes now used. 6800 w. Mines & Min—April, 1905. No. 68858 C.

Stamp Mills.

Stamp Mill Capacity. Discusses methods that have been tried to reach the maximum of capacity with the minimum of loss. 1900 w. Min & Sci Pr—April 15, 1905. No. 69206.

Sudan.

The Possibilities of the Sudan as a Gold Field. W. Broadbridge. Gives the writer's impressions from inspecting several groups of old mines. 2000 w. Min Jour—April 15, 1905. No. 69221 A.

IRON AND STEEL.

Blowing Engines.

Kennedy's Piston Inlet and Outlet Air-Valves for Blowing-Engines. Illustrates and describes four recently installed engines with air-valves of the Kennedy patent horizontal piston type. 900 w. Engng—April 14, 1905. No. 69237 A.

Charging Machine

The Backlund - Burman Traveling Charging Machine for Blast Furnaces. Illustrated detailed description of this apparatus and its working. 1800 w. Ir Age—April 13, 1905. No. 69019.

Dry Air Blast.

Dry Air in the Blast Furnace. A collection of comments from technical papers on the experiments of Mr. Gayley. 7000 w. Ir & Steel Mag—April, 1905. No. 69051 D.

Gayley's Dry Air Blast. F. A. Willcox. Gives results obtained in working out the heat balance of the Isabella and the Lucy furnaces with dry and normal blast, with explanatory remarks. 2300 w. Ir & Coal Trds Rev—March 31, 1905. No. 68913 A.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Hematite.

Brown Hematite Ores. W. R. Crane. On the methods of prospecting, mining, and washing the soft iron ores of the Birmingham district, Alabama. Ills. 4500 w. Mines & Min—April, 1905. No 68857 C.

Sea Barrier.

Sea Barrier at the Hodbarrow Mines. Illustrated description of a barrier 7,000 ft. long, built in a semi-circular line from shore to shore in order to exclude sea-water so that rich iron deposits may be mined. 1800 w. Engng—April 7, 1905. No. 68916 A.

Separation.

Notes on the Magnetic Separation of Scrap Iron from Mined Ore. J. P. Ward. On the need of a mechanical sorter, suggesting a method. 1600 w. Jour S African Assn of Engrs—Dec., 1904. No. 68735 F.

MINING.

Drilling.

Diamond Drilling from the Bottom of a 2,500 ft. Shaft Full of Water. S. C. Thomson. Describes the method of carrying out the work. Plate. 1400 w. Jour S African Assn of Engrs—Jan., 1905. No. 68899 F.

Electric Power.

Electricity Applied to Mining in California. Describes and illustrates mines in Mariposa County, giving a description of the electric equipment of the Mariposa Commercial & Mining Co. as a typical example of an independent plant. 1800 w. Min & Sci Pr—April 8, 1905. No. 68958.

Electricity in Coal Mining. W. B. Clarke. On the applications made of the electric motor and its especial adaptability for such work. Ills. 1800 w. Min Mag—April, 1905. No. 69043 C.

Electricity in the Anthracite Coal Mines. Robert Thurston Kent. Illustrates and describes applications of electricity in the coal mines. 5300 w. Elec Rev, N Y—April 8, 1905. Serial. 1st part. No. 68882.

Explosions.

Explosions in Kansas. Report of Commission on the causes of recent explosions in coal mines of southeastern Kansas. 2500 w. Mines & Min—April, 1905. No. 68861 C.

Explosive Rock. J. B. Jaquet. An account of the phenomena and discussion of the causes. 2000 w. Eng & Min Jour—March 30, 1905. No. 68797.

Peabody Coal Mine Explosion at Sherman, Ill. Richard Newsam. An illustrated account of an explosion caused by excessive use of powder. 2000 w. Mines & Min—April, 1905. No. 68860 C.

Firedamp.

Notes on the Investigation of Fire Damp (Beiträge zur Untersuchung der Grubenwetter). R. Nowicki. An examination of the application of laboratory methods of gas analysis to the study of samples of explosive gases taken from mine workings. 3500 w. Glückauf—March 18, 1905. No. 69129 B.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Mine Cars.

Types of Mine Cars. R. V. Norris. Illustrates and describes general types in use in the Pennsylvania coal mines. 1000 w. Eng & Min Jour—April 27, 1905. No. 69261.

Mining Industry.

Practical Mining. Abstract of a paper read before the Mining Assn. Discusses points of importance to a successful mining man. 2800 w. Cal Jour of Tech—Feb., 1905. No. 69022 C.

Mining Law.

A Proposed Amendment of the Mineral Land Laws. George A. Packard. Gives the amendment suggested, discussing the advantages of the change. 4500 w. Eng & Min Jour—April 27, 1905. No. 69262.

Ore Deposits.

Metasomatic Replacement. James Park. Explains this term as defined by geologists and discusses the probability of its playing an important part in the formation of mineral veins and ore bodies. 1500 w. Eng & Min Jour—April 27, 1905. No. 69263.

Ore Dressing.

The Ferraris Waving Screen. Charles Will Wright. Explains the principle of the Ferraris system of sizing ores, which is practically unknown in the United States, but can be introduced at small expense. Ills. 1400 w. Min Mag—April, 1905. No. 69044 C.

Rolls.

Springs on Crushing Rolls. Lewis Searing. Considers the disadvantages of the spring rolls, and the superiority of rigid rolls. 900 w. Eng & Min Jour—April 6, 1905. No. 68800.

Safety Lamps.

Safety Lamps for Belgian Coal Mines. A summary of experiments undertaken to show that certain regulations for the use of safety lamps at Belgian coal mines were no longer needed and should be repealed. Also discusses the comparative merits of different types of lamps. Ills. 4000 w. Eng & Min Jour—April 20, 1905. No. 69063.

Some Notes for Effecting Economy in the Use of Safety-Lamp Oil. Ellis Barraclough. Read before the Nat. Assn. of Col. Mgrs. Describes an improvement that makes it possible to use cheaper oil, and yet secure better illumination. 2000 w. Ir & Coal Trds Rev—March 24, 1905. No. 68753 A.

Shafts.

Notes on Vertical Shaft-Sinking on the Witwatersrand. H. Fraser Roche. On the methods employed for sinking vertical shafts by machinery, describing an ideal method. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1905. No. 68922 E.

The Kind-Chaudron Method of Shaft-Sinking. L. Ramakers. Illustrates and describes this method, which is particularly applicable to sinking through strata where there is a great influx of water. 1300 w. Min Mag—April, 1905. No. 69042 C.

Timbering.

Anthracite Timbering. Abstract of an article by a practical timberman of twenty-five years' experience. Ills. 2700 w. Mines & Min—April, 1905. No. 68864 C.

The Strength and Life of Mine Timbers. W. H. Storms. Abstract from Trans. Cal. Min. Assn. Notes applying to the Pacific Coast, where only Pacific Coast timbers are used, concerning the timbers best suited to meet the requirements. 1800 w. Min & Sci Pr—April 15, 1905. Serial. 1st part. No. 69207.

Tipples.

Dumping Devices. W. R. Crane. Illustrates and describes dumping devices largely employed in discharging the contents of cars. 2000 w. Eng & Min Jour—April 13, 1905. No. 68929.

Turntable.

Turntable for Inclined Railway (Schwenkbuhne für Geneigte Bahnen). H. Best. Illustrating a form of tilting turntable to enable cars to be transferred from an inclined track to a horizontal one at right angles. 2000 w. Glückauf—March 18, 1905. No. 69130 B.

Winding.

Electric Winding Engine of the Tiremande Mine. Dr. A. Gradenwitz. Illustrates and describes an engine designed for winding 105 tons of coal per hour, from a depth of 400 m., at a speed of 8 m. per second. 1400 w. Elec Rev, Lond—April 14. 1905. No. 69228 A.

On the Electric Drive of Large Reversing Engines Working Intermittently. Maurice Georgi. A comparison of the advantages of electric power over steam for mine hoisting engines. Serial. Part I. 2400 w. Col Guard—April 14, 1905. No. 69235 A.

Winding Engines. W. F. Dam. Considers winding engines generally, and particularly for depths exceeding 1,000 feet, with parallel drums. 8000 w. Mines & Min—April, 1905. No. 68859 C.

MISCELLANY.

Corundum.

Corundum. John L. Cowan. Information as to where found, the production, varieties, preparation for market, &c. 1400 w. Engr, U S A—April 15, 1904. No. 68998 C.

Diamonds.

The Great Premier Diamond. Concerning the mammoth gem recently found in South Africa, with illustrations showing the actual size of the 18 largest diamonds in the world. 1600 w. Sci Am—April 8, 1905. No. 68853.

Nickel.

Treatment of Nickel Ores. Alfred Ernest Barlow. Excerpt from report of the Geological Survey of Canada. Discusses the production of nickel and copper from a sulphide ore. 2500 w. Min Wld—April 15, 1905. No. 68956.

Petroleum.

Oil Fields of the Texas-Louisiana Coastal Plain. N. M. Fenneman. Discusses the location, present condition, and outlook of these fields, their geological structure, the business methods, &c. Ills. 4000 w. Min Mag—April, 1905. No. 69041 C.

The Auditing of Ore Reserves. Discussion of paper on this subject by B. J. Collings. 5700 w. Jour Chem, Met, & Min Soc of S Africa—Feb., 1905. No. 68923 E.

The German Petroleum Industry (Die Deutsche Erdölindustrie). H. Michels. A comparative review of the production of petroleum in various parts of the world, and a discussion of the character of the various oils and their products. Serial. Part I. Glückauf—April 8, 1905. No. 69134 B.

Precious Stones.

The Precious Stone Industry of the United States. Elizabeth A. Reed. Information in regard to the precious stones found and the localities. 2500 w. Sci Am Sup—April 8, 1905. No. 68856.

Sulphur.

The Vesuvius of America Day Allen Willey. An illustrated article describing the sulphur mining industry, and giving an interesting account of its history. 1200 w. Sci Am—April 22, 1905. No. 69084.

Tantalum.

The Occurrence of Tantalum Minerals. David T. Day. On the places where tantalum ore is found in the United States, and on the composition of the ores. 1,400 w. Elec-Chem & Met Ind—April, 1905. No. 68772 C.

Tin.

Hints to Aid the Identification of Stream Tin. Charles H. Walker. Suggestions aiding in recognizing cassiterite, the mineral from which metallic tin is principally produced. 1200 w. Min & Sci Pr—March 25, 1905. No. 68769.

Tin Deposits in Alaska Advance abstract of the geological survey report, prepared by Arthur J. Collier, on developments in 1904. 2000 w. Ir Age—April 6, 1905 No. 68702.

Zinc.

Cadmium in Spelter. W. R. Ingalls. On the amount found and its influence, and related information. 1400 w. Eng & Min Jour—April 13, 1905. No. 68928.

Zinc Mining and Smelting in Southwestern Virginia. Edwin Higgins, Jr. A description of operations as carried out in this region. 1800 w. Eng & Min Jour—March 30, 1905. Serial. 1st part. No. 68798.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

British Railways.

Methods of Operating English Railways (Betriebseinrichtung der Englischen Eisenbahnen). Prof. Cauer. A fully illustrated account of British railway terminals and methods of operation, in the light of German observation. Serial. Part I. 4000 w. 1 plate. Glasers Annalen—April 1, 1905. No. 69126 D.

Japan.

Japanese Railways. A. R. Bell. An illustrated article giving information of interest in regard to the railway development and service. 2000 w. Ry & Loc Engng—April, 1905. No. 68782 C.

Train Speeds.

The Swiftest Trains in Europe and America (Die Schnellsten Züge in Europa und Amerika). Arnold Kramer. A tabulated comparison of standard trains on the principal railways of England, France, and the United States. 2000 w. Glasers Annalen—April 1, 1905. No. 69127 D.

MOTIVE POWER AND EQUIPMENT.

Benzine Locomotive.

The Work of the Oberursel Benzine Locomotive at the Karawanka Tunnel (Die Oberurseler Spiritus-Benzin-Lokomotive beim Bau des Karawankentunnels). An illustrated account of the use of locomotives using benzine motors, as applied to contractors' work on the Karawanka tunnel in the Tyrol. 1800 w. Glasers Annalen—April 1, 1905. No. 69128 D.

Car Wheels.

See Mechanical Engineering, Machine Works and Foundries.

Cars.

50-Ton Mineral Wagons on French Railways. Illustrated descriptions of types of high-capacity mineral wagons. Also a bogie truck for passenger carriages is shown. 500 w. Engng—April 7, 1905. No. 68917 A.

Steel Underground Gondolas for the B. & O. Illustration, drawings and description of drop-end gondolas of 100,000 lbs. capacity. 500 w. R R Gaz—Vol. XXXVIII, No. 15. No. 68942.

The Capacity of Freight Cars (La Capacité des Wagons à Marchandises). E. Biard. A discussion of the relation of the size of cars to traffic efficiency, with especial reference to the increasing capacity of cars in the United States, compared with other countries. 9000 w. 1 Plate. Mem Soc Ing Civ de France—Jan., 1905. No. 69163 G.

Couplers.

Automatic Couplers (Attelage Automatique). M. Boirault. An illustrated description of the improved automatic coupler designed for use on the State Railways of France. 2500 w. Revue Technique—March 25, 1905. No. 69141 D.

Electric Locomotives.

See Street and Electric Railways.

Electrification.

The Parting of the Ways—From Steam to Electricity. Discusses the important changes from steam to electric traction in progress on the New York Central Railroad near New York. Illustrates the latest steam locomotive and the new electric locomotive for the express service on this road. 1600 w. Sci Am Sup—April 8, 1905. No. 68854.

Locomotives.

A Unique Railroad Relic. Illustration, with description of the "Novelty," one of three engines which competed at the famous trial of locomotives at Rainhill, Lancashire, in Oct., 1829. 1200 w. R R Gaz—Vol. XXXVIII, No. 15. No. 68943.

Balanced Compound for the New York Central. Illustrated description of a 4-cylinder balanced compound of the Vauclain type. 300 w. Ry Age—March 31, 1905. No. 68767.

Engine Failures—Use Both Injectors Regularly. J. W. Reading. Remarks on the feeding of boilers, and faulty practice. 1000 w. Ry & Loc Engng—April, 1905. No. 68784 C.

Foreign Tank Locomotives. Illustrated descriptions of types. Also editorial calling attention to difference in practice in

Europe and America. 1800 w. Ry Age—April 21, 1905. No. 69093.

Possible Improvements in Locomotive Design. Walter Longland. Read before the Jr. Inst. of Engrs. Examines the structure and working of a locomotive and describes structural alterations proposed to effect improvements. 4000 w. Mech Engr—March 25, 1905. No. 68745 A.

Setting the Frames. James Kennedy. Remarks on the construction of engines, and especially the treatment of the frames. 1700 w. Ry & Loc Engng—April, 1905. No. 68783 C.

The New Express Locomotives of the Bavarian State Railways (Die Neuen 2-5 und 3-5 Gekuppelten Schnellzug-Lokomotiven der Bayerischen Staatsbahnen). E. Weiss. Illustrating and describing heavy compound four-cylinder express engines by Maffei, of Munich. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 18, 1905. No. 69100 D.

Two-Cylinder Compound for the "Soo" Line, with Superheater. Illustrated description of a consolidation engine with the Schenectady superheater. 600 w. Ry Age—April 14, 1905. No. 68940.

Locomotive Tests.

Locomotive Tests at St. Louis. Extract from Bulletin No. 4 published by the Penn. Ry. Co., describing tests of Pennsylvania Railroad consolidation locomotive No. 1499. Ills. 4500 w. R R Gaz—Vol. XXXVIII, No. 14. No. 68819.

Lubricator.

Automatic Lubricator for Air Cylinder of Air Pump. T. M. Henderson. Drawings and description of a lubricator for air brake pumps. 700 w. Ry & Loc Engng—April, 1905. No. 68786 C.

Motor Cars.

A New Gasoline Electric Motor Car. Illustrated description of a car deriving its motive power from a four-cylinder gasoline engine of the marine type, direct connected to a direct-current generator, which supplies current to four 35 h. p. motors mounted on the trucks. 1400 w. Ry & Engng Rev—April 8, 1905. No. 68880.

Self-Propelled Passenger Coach. Illustration, with brief description of a car equipped with six-cylinder standard gasoline engine for local traffic at Portland, Ore. 600 w. Automobile—April 1, 1905. No. 68761.

The Daimler Petrol Automobile Car (Automotrice à Pétrole Daimler). R. Bonnin. Illustrated description of a passenger car for main-line local traffic, propelled by a Daimler internal-combustion motor. 1200 w. Revue Technique—March 25, 1905. No. 69138 D.

The Use of Automobile Vehicles on Railways (Emploi des Voitures Automobiles sur les Lignes de Chemins de Fer). F. Barbier. Notes concerning the use of self-propelled cars in various countries for local traffic on main-line railways. 2000 w. Génie Civil—March 18, 1905. No. 69115 D.

Rolling Stock.

Suburban Equipment. Illustrates and describes the new locomotives and coaches put in service on the Chicago & Western Indiana R. R. 1200 w. Ry & Engng Rev—April 22, 1905. No. 69099.

Tipping Car.

Fifteen-Ton Tipping Car (Kippwagen von 15 t. Tragfähigkeit). Illustrating an improved tipping car for sand, gravel, etc., arranged with the ordinary hook coupling as well as the Janney type of coupler. 800 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 1, 1905. No. 69110 D.

Tires.

Tire Wear and Tire Turning. F. W. Williams. Illustrates and describes styles of radius calipers for determining which tire has worn the shortest measurements from the center of the axle. Discussion. 3000 w. Pro Cent Ry Club—March 10, 1905. No. 69001 C.

Unloaders.

Railway Tipping Unloaders (Eisenbahnwagenkipper). Fr. Frölich. Describing a tipping platform for immediate unloading of car loads of sugar beets. 1200 w. Zeitschr d Ver Deutscher Ing—March 18, 1905. No. 69101 D.

Vibration.

New Apparatus for Recording the Vibration of Railway Cars. Emile Guarini. An illustrated description of the Sabouret apparatus and its working. 1400 w. Sci Am Sup—April 29, 1905. No. 69258.

Wheel Pressures.

Safe Limits of Working Load for Wheel Pressures. Tabulating the safe pressures for various diameters and surfaces for car wheels and for small roller bearings. 1800 w. Eng News—April 20, 1905. No. 69082.

NEW PROJECTS.

Africa.

The Uganda Railway Report. Information from this report concerning the railway, and steamboat service on Lake Victoria. 1800 w. Engr, Lond—April 14, 1905. No. 69239 A.

New Line.

The New Chicago-St. Louis Line of the Chicago & Eastern Illinois Ry. Describes a new line opened for traffic Sept. 1, 1904. 2300 w. Eng News—April 6, 1905. No. 68842.

Simplon Routes.

Connecting Routes to the Simplon (Les Voies d'Access au Simplon). Paul Olivier. With map showing existing lines and proposed new railway connections on the Swiss and French side of the Simplon tunnel. 2000 w. Revue Technique—March 25, 1905. No. 69140 D.

PERMANENT WAY AND BUILDINGS.

Engine Houses.

New Engine Houses at Elkhart, L. S. & M. S. Ry. Illustrates and describes this example of the latest phase of development of engine houses, which makes running repairs possible, and furnishes a system of piping for blowing off, washing out and filling boilers. 4500 w. Ry & Engng Rev—April 1, 1905. No. 68765.

Improvements.

Pennsylvania Improvements at Wilmington, Del. Illustrates and describes improvements including a brick arched viaduct, drawbridge, and other changes. 1200 w. Ry Age—March 31, 1905. No. 68766.

Rails.

A Railway Rail and Its Relation to the Wheel and Tie. W. F. Gould. Discusses the changes in rails by wear, and the creeping of rails, and the movements the rail has to resist. General discussion. 3500 w. Pro Iowa Ry Club—March 13, 1905. No. 69003 C.

The Best Metal for Rails. P. H. Dudley. Abstract of a report to the Int. Ry. Cong. giving the result of American experience. 1300 w. Ir & Coal Trds Rev —March 24, 1905. No. 68754 A.

Repair Shops.

A Plan for Maintaining Railroad Repair Shop Machinery. M. K. Barnum. On the importance of well-equipped toolrooms. With a very interesting discussion. 17000 w. Pro W Ry Club—March 21, 1905. No. 68999 C.

Round-Houses.

Round-House Framing. R. D. Coombs. Gives the writer's ideas of desirable construction. Ills. 2500 w. Pro Am Soc of Civ Engrs—April, 1905. No. 69266 E.

Signalling.

Automatic Block Signals. Ralph Scott. Illustrates and describes the standard Hall electro-gas signal. 3000 w. Am Elect'n—April, 1905. No. 68813.

Station.

The New Central Station at Sidney, New South Wales. Illustration with description of a new station under construction costing nearly $5,000,000. 2700 w. Eng News—March 30, 1905. No. 68831.

Terminals.

Canadian Pacific Improvements at Victoria. An illustrated article describing the improvement of railroad property at this point, including the building of a fine hotel. 1500 w. R R Gaz—Vol. XXXVIII, No. 16. No. 69076.

Ties.

Experiments with Treated Cross-Ties in Texas. Notes from a report by Dr. Hermann von Schrenk, of the results of extensive tests made on railroad ties. 4500 w. Eng Rec—April 15, 1905. No. 68972.

Yards.

Design and Operation of a Modern Freight Yard. Joseph T. Richards. Considers a plan for a general yard design and the method of operating it. Discussion. 3000 w. Pro Engrs' Club of Phila —April, 1905. No. 69035 D.

Hump Yards at Dewitt, N. Y. C. & H. R. R. R. Gives plan of the yards, showing the great network of tracks and the hump by which the distribution and classification of freight traffic is effected. 600 w. Ry & Engng Rev—April 1, 1905. No. 68764.

TRAFFIC.

Rates.

A Simple Scheme of Rate Regulation. Judge P. S. Grosscup. Extracts from an address before the Union League Club, Chicago. Discusses various phases of the rate question, and gives his opinion in favor of a transportation department of government. 3500 w. Ry Age—April 28, 1905. No. 69279.

Federal Regulation of Railway Rates. Albert N. Merritt. A discussion of this subject, concluding that government regulation, beyond that now exercised, is a dangerous policy. 3300 w. Ry Age—April 7, 1905. No. 68881.

Government Rate Making and the Constitution. George R. Peck. Abstract of an address delivered before the Union League Club, Chicago. Considers that the making of rates by the Interstate Commerce Commission would result, in many cases, in a violation of the constitution. 2200 w. Ry Age—April 21, 1905. No. 69092.

Railwav Rate Regulation.—Its Bearing Upon Public Transportation. James L. Cowles. Advocating the extension of the postal system to general transport rates as a solution of the railway-rate problem. 1000 w. Sci Am Sup—April 22, 1905. No. 69088.

STREET AND ELECTRIC RAILWAYS

Car Designs.

Car Designs and Carrying Capacity. John P. Fox. Discusses the seating arrangements of some 24 different types of cars, with suggestions. Editorial also. 7700 w. St Ry Jour—April 1, 1905. No. 68815 C.

Combination.

The West Penn Railways System. Illustrated description of a system formed by the union of several disconnected lines in western Pennsylvania. 3500 w. St Ry Rev—April 15, 1905. No. 69067 C.

Controllers.

The Burning Out of Electric Street-Car Controllers. Sydney W. Ashe. Gives an account of experimental investigations to study the behavior of an arc during the time that elapses for a fuse to blow, and discusses the remedy. 1500 w. Eng News—April 20, 1905. No. 69080.

Discussion.

Development in Electric Traction. Discussion of paper presented by W. B. Potter at the January meeting. 11800 w. Pro N Y R R Club—March 17, 1905. No. 69002.

Electric Locomotives.

Control of Electric Locomotives. William Cooper. Considers methods of controlling the pull on the coupling. 2000 w. Elec Rev, N Y—April 8, 1905. No. 68883.

Oerlikon Electric Locomotives. C. O. Mailloux. Illustrated description of two types of single-phase a. c. electric locomotives, with information concerning them. 2400 w. St Ry Jour—April 8, 1905. No. 68887 C.

The New Electric Locomotives for the Valtellina Railway (Neue Elektrische Lokomotiven Type R. A. 1903, für die Valtellinabahn). E. Cserhati. A fully illustrated description of the new three-phase locomotives for the Lecco-Colico-Sondrio line in Northern Italy. Two articles. 5000 w. Zeitschr f Elektrotechnik—April 9, 16, 1905. No. 69156 each D.

Evolution.

Synopsis of Paper on the Evolution of the Street Railway. Richard McCulloch. Some interesting statements in regard to the progress and growth. 1300 w. Pro St Louis Ry Club—March 19, 1905. No. 69000.

Funeral Car.

Funeral Car at Buffalo. Brief illustrated description. 300 w. St Ry Jour—April 1, 1905. No. 68816 C.

Interurban.

The Columbus, Newark & Zanesville Electric Railway. Illustrated detailed description of this Ohio line and its equipment. 3500 w. St Ry Jour—April 15, 1905. No. 68944 C.

Manila.

The First Philippine Electric Railway. A brief illustrated article giving information of this recently opened line. 900 w. Sci Am Sup—April 29, 1905. No. 69255.

Opening of the Electric Railway System in Manila, P. I. Illustrated detailed description of the reconstruction and electrification of the street railways, and matters related. 3500 w. St Ry Jour—April 29, 1905. No. 69310 C.

Motive Power.

The Attitude of the Steam Roads. Louis Bell. Discusses some phases of the present situation in railway operation. 2000 w. St Ry Jour—May 6, 1905. No. 69445 C.

Permanent Way.

Tramways Permanent-Way Construction and Maintenance. James Lord. Read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Results of the author's experience of 21 years in the repairing and construction of municipal tramways. 3000 w. Elec Engr, Lond—March 24, 1905. No. 68748 A.

Philippines.

Electric Lighting and Railway Construction in the Philippines. Illustrated description of the reconstruction and extension of the lighting and power system, the electrification of the horse car lines and of a short steam line. 2500 w. Elec Wld & Engr—May 6, 1905. No. 69426.

Power Supply.

Dundee Power Supply. An explanation of a system of charging for electrical energy recently placed before the Tramway Committee of the Dundee Corporation. 1800 w. Elec Engr, Lond—April 7, 1905. No. 68984 A.

Rail Bonding.

Rail Bonding on the Brooklyn Heights Railroad. Howard C. Forbes. Illustrated description of heavy bonding where not only the track but the longitudinal girders of an elevated structure were used to carry the return current. 1600 w. St Ry Rev—April 15, 1905. No. 69070 C.

Railway Motors.

Is a Universal Type of Railway Motor Advisable? A. H. Armstrong. Discusses the various types of motors and their advantages and concludes that while uniformity is desirable, the best interests of a system are conserved by adapting the motive power to the requirements. 2800 w. St Ry Jour—April 15, 1905. No. 68045 C.

Rolling Road.

A New Rolling Road at Cleveland, Ohio. D. A. Willey. Illustrated description of the application of the electric current in connection with a rolling roadway of pulling loaded vehicles up a high grade. 900 w. Elec Rev, N. Y.—April 8, 1905. No. 68885.

Rolling Stock.

Improvements on the Motor Cars of the Metropolitan West Side Elevated Railway Company, Chicago. An illustrated article describing a number of important improvements, especially in wiring. 5500 w. St Ry Jour—April 22, 1905. No. 69096 C.

Single-Phase.

A New Single-Phase Railway Equipment. A. Frederick Collins. Reviews some of the three-phase alternating current systems of Europe and gives an illustrated description of the single-phase alternating current equipment of the General Electric Company. 1700 w. Sci Am Sup—April 22, 1905. No. 69089.

Single-Phase Line Construction. Theodore Varney. Illustrates and describes features developed with the view of making this high voltage system thoroughly safe and reliable with a minimum cost. 1100 w. Elec Club Jour—April, 1905. No. 69025

General Electric Single-Phase Railway. Illustrated description of details of the single-phase system between Pontiac and Odell in Illinois. 1000 w. Elec Wld & Engr—May 6, 1905. No. 69428.

The Bloomington, Pontiac & Joliet Single-Phase Electric Railway. John R. Hewett. Illustrated detailed description of the first line of single-phase current above, opened for public service in the United States. 2800 w. St Ry Jour—May 6, 1905. No. 69442 C.

Signals.

Automatic Signal and Safety Systems as Applied to Electric Railways. Edward Taylor. Deals chiefly with the weak points of the signal systems, showing that there is still room for improvement. 3500 w. St Ry Jour—May 6, 1905. No. 69444 C.

Subway Accident.

Another Accident in the New York Subway. An illustrated account of the accident near 168th street on March 29, with editorial. 2000 w. R R Gaz—Vol. XXXVIII, No. 14. No. 68820.

Subways.

Chicago's Underground Freight Traffic. George E. Walsh. Compares conditions in New York and Chicago, and gives information in regard to the tunnels of the Illinois Tunnel Company. 1600 w. Sci Am Sup—April 1, 1905. No. 68847.

The Double Deck Subway System. Illustrates and describes a subway designed some years ago by J. W. Reno, for conditions under Broadway, New York, with discussion of its advantages. 1200 w. Sci Am—April 8, 1905. No. 68852.

Switches.

The Operation of Automatic Electric Track Switches. Sidney Diamant. An illustrated description of types of electric switches on trial in New York City. 3000 w. St Ry Jour—April 1, 1905. No. 68,817 C.

Testing Car.

New Testing Car of Berlin Traction Company. C. L. Durand. Illustrated description of a model testing and inspection car equipped for making all necessary measurements. 1200 w. Elec Rev, N. Y. —April 8, 1905. No. 68886.

Third Rail.

Third Rail Connections. William A. Del Mar. Outlines a few general principles the neglect of which has proved detrimental to several systems. 1200 w. Elec Wld & Engr—April 22, 1905. No. 69211.

Train Control.

The Electro-Pneumatic System of Train Control. P. C. McNulty, Jr. Illustrated description of this system which has been developed by the Electric Company. 4000 w. Elec Club Jour—April, 1905. No 69026.

Ventilation.

Car Ventilation. Edward Taylor. Gives information gained while testing an important city electric railway system, describing methods and giving other related information. 3500 w. St Ry Jour—April 15, 1905. No. 68946 C.

West Ham.

The Tramway System of West Ham. Describes the conditions in and around this borough, illustrating and describing the contruction of the electric tramways, the power station, rolling-stock, &c. 5000 w. Tram & Ry Wld—April 6, 1905. No. 69075 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

Concrete.

Reinforced Concrete. By A. W. Buel and C. S. Hill. Size, 9 in. by 6 in.; pp. x, 434. Price, $5.00. New York: Engineering News Publishing Company.

With the increasing interest and numerous applications of reinforced concrete as a method of construction there has arisen a demand for reliable text books for the use of the engineer and student upon this new system of construction. The present volume consists of two independent parts, the first portion, from the pen of a well-known civil engineer, treating of the scientific principles involved in the proportioning of reinforced-concrete structures, and the second part including a large number of executed examples of foundations, bridges, conduits, reservoirs, and other structures. There are also chapters discussing the practical methods employed in reinforced-concrete work, the whole forming a complete manual of the subject.

Mr. Buel examines the various theories, as applied to beams, columns, walls, and arches, discussing the methods of Considère and of Thacher, with tables for beams of various depths and spans computed from Thacher's formulas. The computations for retaining walls, dams and similar structures are examined graphically, while the elastic theory for arches, as confirmed by the Austrian tests, is given, together with the approximate methods of Von Emperger.

The manner in which Mr. Buel has treated this whole question of proportions and design renders the book of especial value for the working engineer, the methods given being practical and applicable to a great variety of structures and involving only such a knowledge of mathematics as should be available in any office. In the present state of knowledge as to the properties of reinforced concrete it is useless to attempt any extreme degree of precision in computations, and the methods given by Mr. Buel are entirely within the practical limits of the materials employed.

The second portion of the book, due to Mr. Hill, contains a wealth of illustration in the form of working drawings of executed work, and thus appeals directly to the engineer and builder in similar lines of work.

Electricity.

Alternating Current Machinery. By William Esty, S. B., M. A. Size, 10 in. by 7 in.; pp. 432. Price, $3.75. Chicago: American School of Correspondence.

It is generally considered that the phenomena of alternating current machinery cannot be properly treated without the use of the higher mathematics, and hence most books on the subject are practically unreadable for the practical station man and electrician. Professor Esty has met this objection in the present work, which forms one of the excellent set of books issued by the American School of Correspondence of the Armour Institute of Technology, and he has shown that the subject can be very thoroughly explained to any one possessing a knowledge of no more mathematics than algebra, geometry, and trigonometry. By the use of graphical and geometric methods rather than those of analysis, and by the reduction of abstract and arbitrary statements to a minimum, the study of a subject naturally difficult is rendered as simple as possible.

The work begins with a discussion of the principles of the alternator, followed by descriptions of commercial types of alternators, while succeeding chapters treat of synchronous motors, transformers, rotary converters, induction motors, and the various appliances required for syitchboard, station, and line service. The book is copiously illustrated with diagrams and examples of actual installations, and forms a very complete treatise upon one of the most important departments of applied electricity.

Gas Engines.

Gas Engines and Producer-Gas Plants. By R. E. Mathot. Translated by Waldemar B. Kaempffert. Size, 9 in. by 6 in.; pp. xiv, 314. Price, $2.50. New York: Norman W. Henley Publishing Co.

This is a thoroughly practical book by an author who is both a practical and scientific man, and as such it is a welcome contribution to an important department of technical literature. Leaving aside elaborate theories and thermodynamic studies, Mr. Mathot gives the purchaser and user of the gas engine the benefit of his extensive practical experience in all the details of selection, installation, and operation of these machines. The subject of gas producers, both pressure and suction, is fully discussed, and the practical difficulties which are encountered in the operation of gas-power plants are indicated, and the remedies suggested. The chapters on pressure gas producers and on suction gas producers are of especial value, and the latter system appears to offer great promise in extending the use of internal-combustion motors for small and medium powers.

The translation is excellently done, with the exception of a curious incompleteness in the conversions of the metric values into their British equivalents, thermal values per cubic metre being converted into B. T. U. per 35.31 cubic feet instead of per cubic foot; and the calorific values of coals into B. T. U. per 2.2 pounds, instead of per pound, the result being the presentation of familiar values in wholly unfamiliar forms. The conversion is readily completed, however, and otherwise the book is altogether satisfactory.

Panama.

Problems of the Panama Canal. By Brig.-Gen. Henry L. Abbot, U. S. A. Size, 8 in. by 5 in.; pp. xii, 248. Price, $1.50. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

General Abbot has done excellent service by gathering in this volume much valuable information concerning the Panama canal, and the problems which must be solved in its successful completion. The unsurpassed opportunities possessed by Gen. Abbot by reason of his official connection with the *Comité Technique* and with the Commission of the New Panama Canal Company give ample assurance of the accuracy of his information, while his high reputation as an engineer and his familiarity with hydraulic problems give his opinions great weight.

After a brief historical introduction and a consideration of the rival routes for an isthmian canal, Gen. Abbot proceeds to discuss the physical conditions on the isthmus, including the topography, geology, and climatology of the region. This is followed by an examination of the great problem of the undertaking, the Chagres river and its regulation. Although the difficulties of the work are great, Gen. Abbot believes that they have been overestimated, and states that the control of the Chagres is, in his opinion, a less formidable task than that of the regulation of the Warrior and Black Warrior rivers, of Alabama, a work proceeding without attracting especial attention.

In examining the various projects for the canal, Gen. Abbot expresses his strong approval of a lock canal with dual lake control of the Chagres, dams being built at Bohio and at Alhajuela, the summit level being 20 metres above sea level. The reasons for this view are fully set forth in the book, and the convincing nature of the arguments will be appreciated by any one who examines the subject in the light of the information contained in the volume. The book is well illustrated by numerous diagrams, and a large folding map of the route of the canal is given, reprinted from the issue of this Magazine for February, 1900.

BOOKS RECEIVED.

Descriptive Geometry for Students of Engineering. By James Ambrose Moyer. New York: John Wiley and Sons. London: Chapman and Hall, Limited.

American Society for Testing Materials. Proceedings of the Seventh Annual Meeting. Philadelphia: Office of the Secretary, University of Pennsylvania.

The Testing of Continuous Current Machines in Laboratories and Test Rooms. By Charles Kinzbrunner. New York: John Wiley and Sons.

The Principal Professional Papers of Dr. J. A. L. Waddell. Edited by John Lyle Harrington. New York: Virgil G. Hewes.

Marine Engines and Boilers. Translated from the German of Dr. G. Bauer by E. M. Donkin and S. Bryan Donkin. Edited by Leslie S. Robertson. London: Crosby Lockwood and Son. New York: The Norman W. Henley Publishing Company.

Steam Pipes, Their Design and Construction. By W. H. Booth. New York: The Norman W. Henley Publishing Company. London: Crosby Lockwood and Son.

A Handbook for Superintendents of Construction, Architects, Builders and Building Inspectors. By H. G. Richey. New York: John Wiley and Sons. London: Chapman and Hall, Limited.

Practical Electric Light Fitting. By F. C. Allsop. New York: The Macmillan Co. London: Whittaker and Co.

American Telephone Practice. By Kempster B. Miller. Fourth Edition. Enlarged and Entirely Rewritten. New York: McGraw Publishing Company.

A Treatise on Concrete, Plain and Reinforced. By Frederick W. Taylor and Sanford E. Thompson. New York: John Wiley and Sons. London: Chapman and Hall, Limited.

THE
ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXIX. JULY, 1905. No. 4.

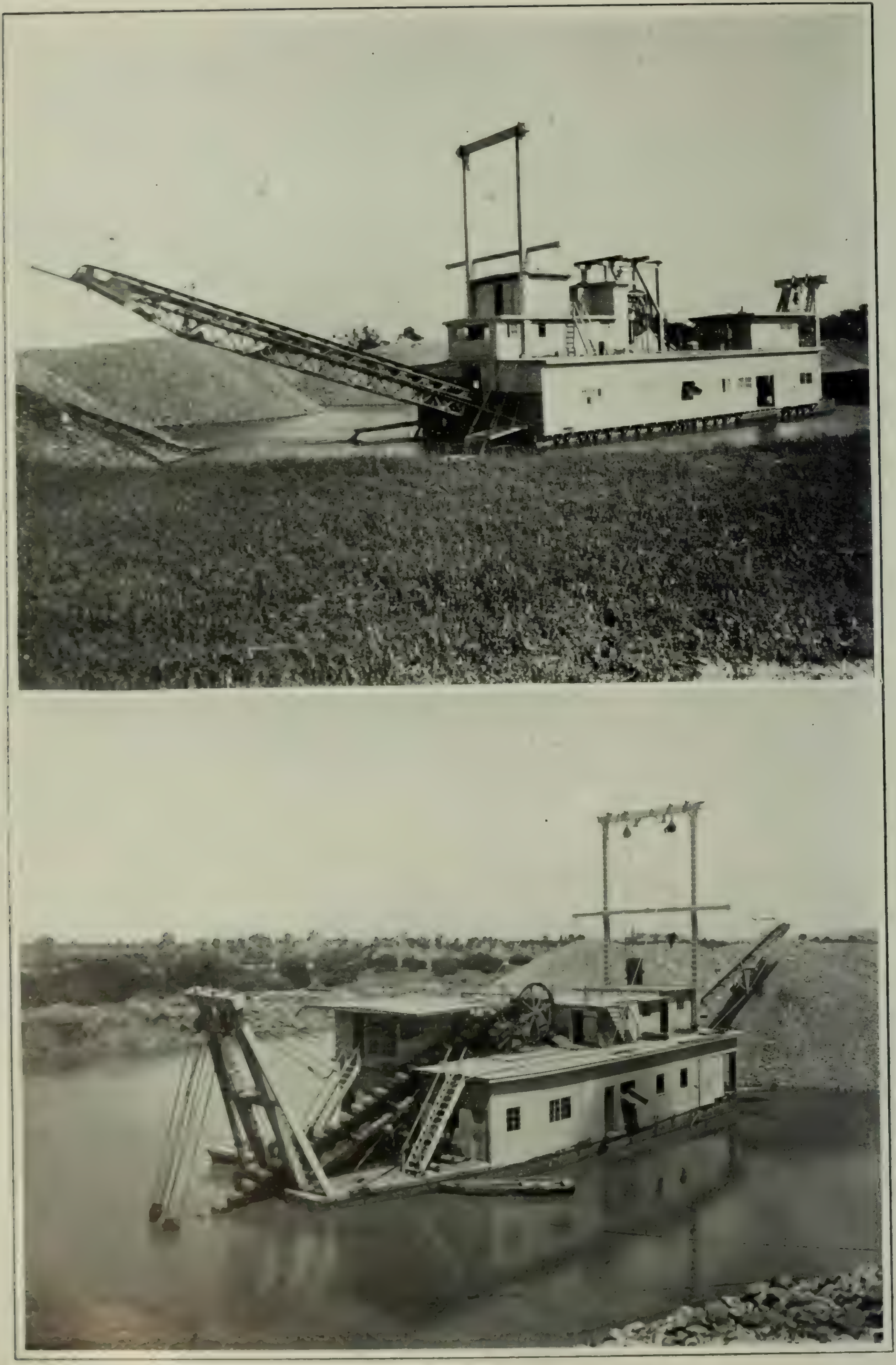
THE GOLD SHIPS AND THEIR CARGOES.

By Alex. Del Mar, M. E.

Mr. Del Mar's ranking position as an authority upon the production and the use of the precious metals as money, will lend added impressiveness to his estimate of the certain effect of the gold dredge in multiplying the world's output of gold. His paper will shortly be followed by the announcement of two most important contributions upon closely related topics, to appear immediately in THE ENGINEERING MAGAZINE. Both will be by the very highest authorities in the field. Together they will serve to forecast and interpret accurately the total output of gold in the near future, and its effect upon the expansion of industry and commerce.—THE EDITORS.

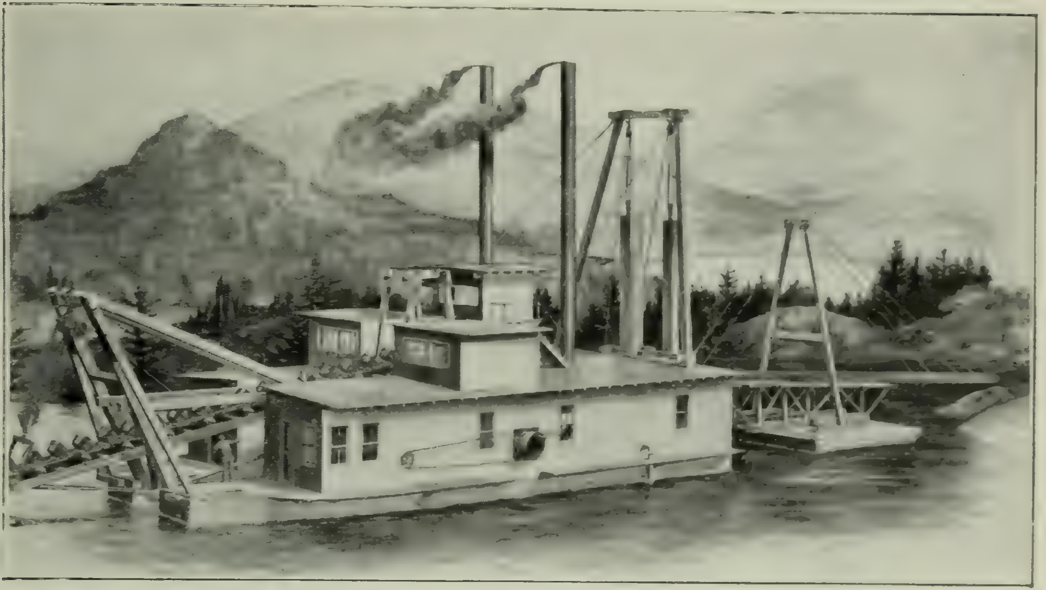
THERE is a strange machine, a sort of phantom ship, which at this moment is beginning to move over the abandoned placers of California to gather up their neglected treasures, and which in a few years will move over the placers of Siberia, Brazil, and Peru, to gather up their wealth, until even the present unprecedented and phenomenal product of gold will be doubled. Ten years ago, the world's annual yield of the yellow metal was half a million dollars per diem; today it is a million; within the next ten years it will be two millions. The social and economical consequences of this tremendous development of gold mining are almost beyond calculation. Without discussing the consequences, let us examine the fact.

The increase of gold production during the past decade has been owing chiefly to two causes—the abandonment of silver for gold mining on the part of the miners; and the invention of the cyanide process. Both of these impulses have operated upon quartz mining—not upon the placers. Now comes a new and more powerful impulse, a weird invention, a wonderful thing, a "Gold Ship" that moves over the land and that during its strange course extracts



TWO EXAMPLES OF BUCYRUS GOLD DREDGES AT WORK.

The upper figure is the "Cherokee No. 1," owned by the Cherokee Gold Dredging Co.; the lower is the "[illegible]," owned by the Boston-Oroville Mining Co. The machinery for both was [illegible] by The Bucyrus Co., South Milwaukee, Wis., while the hull construction and installation was done by the Western Engineering and Construction Co., San Francisco, Cal.

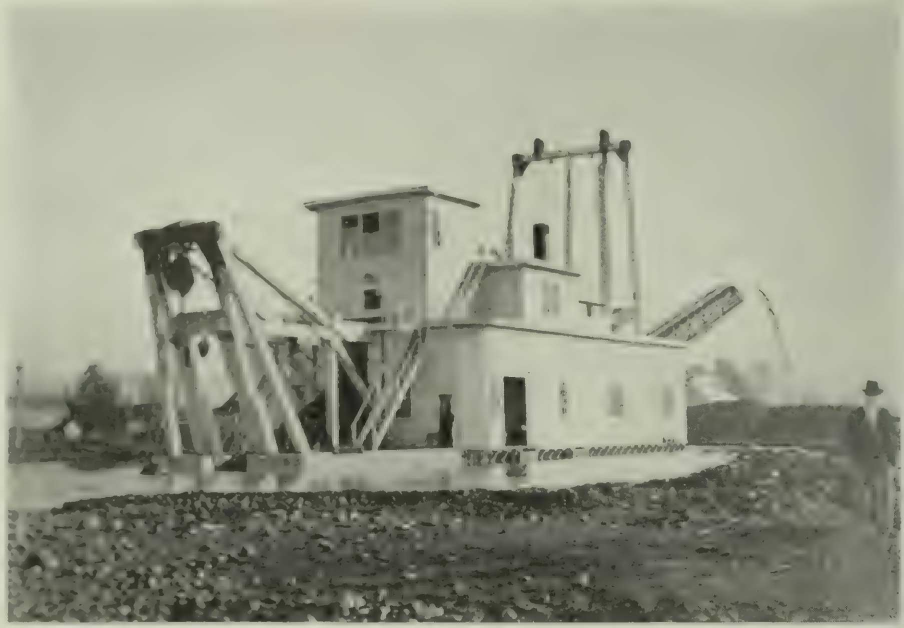


GOLD DREDGE BUILT FOR THE BONANZA BASIN GOLD-DREDGING COMPANY, YUKON RIVER.

Hull 106 by 36 ft.; draught 4 ft.; deck 3 ft. 6 in. above water line; scow 34 ft. 4 in. long; sluice boxes 105 ft. 10 in. long; total overall length 173 ft. 6 in.; will dig to depth of 36 ft.; capacity of buckets 5 1-3 cu. yd.; capacity per day 2,000 cu. yd.; this is the latest type of dredge built by the Allis-Chalmers Company.

every particle of gold out of the long neglected placers, and turns it over to the ship-master. To predict that this machine will double the present product of gold within ten years, is one of the safest of prophecies; it may do much more.

Gold is the most widely diffused of all the metals. There are in California hundreds of square miles—yes, miles—of auriferons, or golden placers, which hitherto have been worked only by hand, or else, being too "poor" to work by hand, while the hydraulic process was practically forbidden by the Supreme Court, have not been worked at all. They contain from 5 to 25 cents in gold to the cubic yard. The gold dredge will extract their entire auriferous contents at a profit, and throw the gold upon the mints of the world. Oregon, Washington, British Columbia, and Alaska possess other auriferons; so do Mexico, Guatemala, Honduras and Costa Rica; so also do Colombia, Equador, Peru, and Chile, especially Peru. I say nothing of Colorado, Idaho, and the other placer fields of Western America. Rich as many of them are, they are relatively unimportant. Greater in extent and richer than any of these are the auriferons of Brazil, Australia, and Siberia. The world is not only going to be saturated with gold; it is going to be nauseated. The Gold Ships will sail over all of these lands and discharge their precious cargoes into the



GOLD DREDGE "EL ORO NO. 1," EL ORO DREDGING CO., OROVILLE, CAL.
Buckets 5 cu. ft. Designed and built by Link Belt Machinery Co., Chicago.

mints. Already are they established in Colombia, New Zealand, and Siberia; a few in each country, soon to be followed by many.

A brief statement of what the principal auriferons have produced from hand labor will perhaps prepare us better to appreciate what they are capable of yielding to this amphibious invention:—

During the 90 years from 1710 to 1800 the placers of Brazil produced by slave labor 750 million dollars in gold.

During the 30 years 1848 to 1878, the placers of California produced, mostly by hand labor, 880 millions in gold.

During the 27 years, 1851 to 1878, the placers of Australia produced, mostly by hand labor, 900 millions in gold.*

During the 75 years, 1830-1904 inclusive, Russia produced, largely from the placers of Siberia, 1,300 millions in gold; the present production being about 25 millions a year, and the Gold Ships hardly yet at work.

During the past 10 years, 1895-1904, the placers of Alaska produced, chiefly by hand labor, 140 millions in gold.†

All these placers or auriferons can be profitably worked over by

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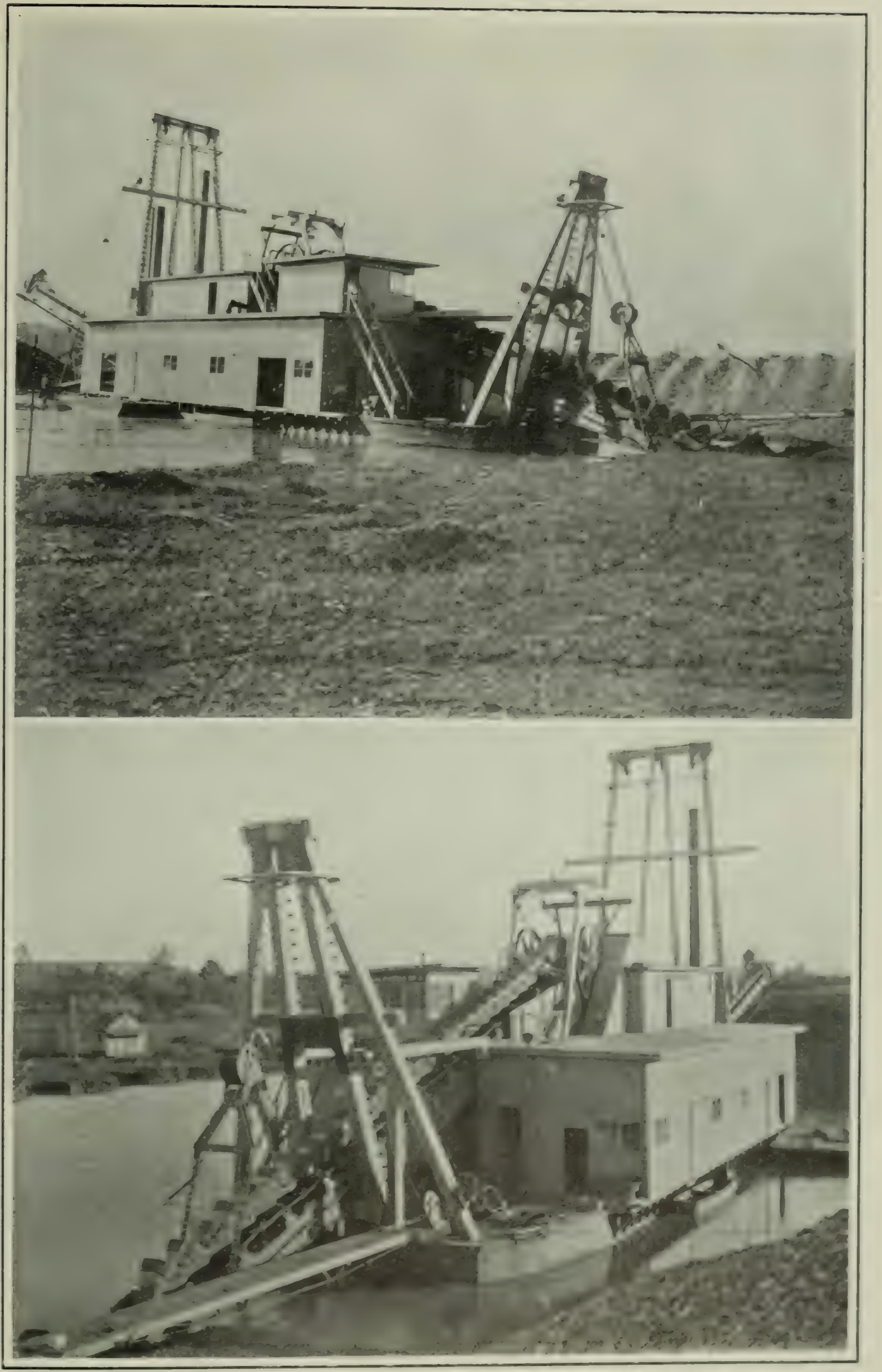
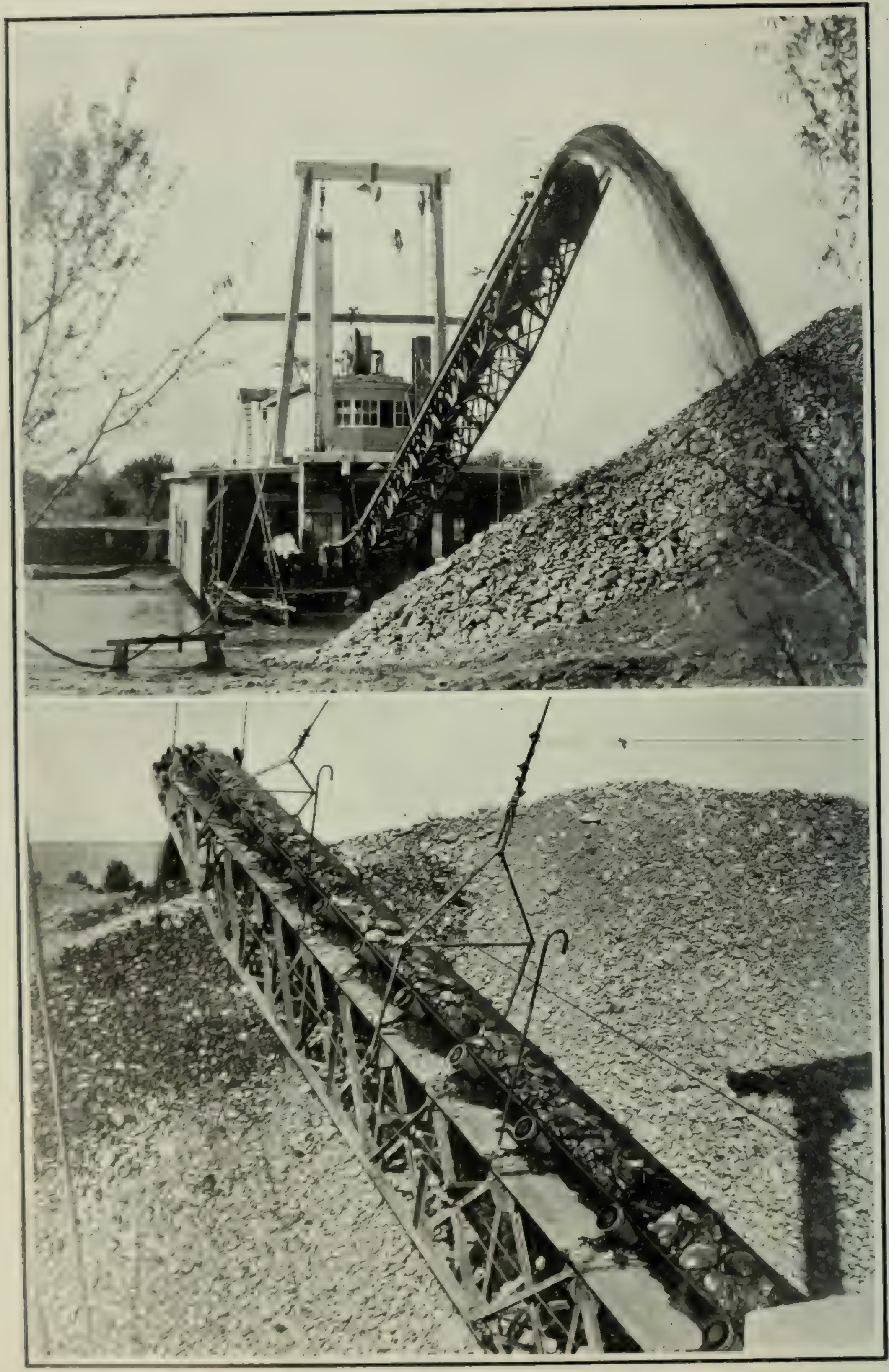
* *History of the Precious Metals*, 1st ed., p. 124.

† *Ibid.*, 2nd ed., [illegible] 410 and Supplements.



ELEVATOR DREDGE OWNED AND OPERATED BY THE BOSTON & CALIFORNIA DREDGING CO., OROVILLE, CAL.

The principal dimensions are:—length, 100 ft.; width, 38 ft.; ladder, 78 ft.; stacker, 90 ft.; will dig 35 ft. below water level; 95 buckets, 5 cu. ft. capacity. In Jan., Feb., and March, 1905, averaged 85,450 cu. yd. per month. Built by Marion Steam Shovel Co., Marion, Ohio.



GOLD DREDGE STACKING ITS TAILINGS BY A BELT CONVEYOR.

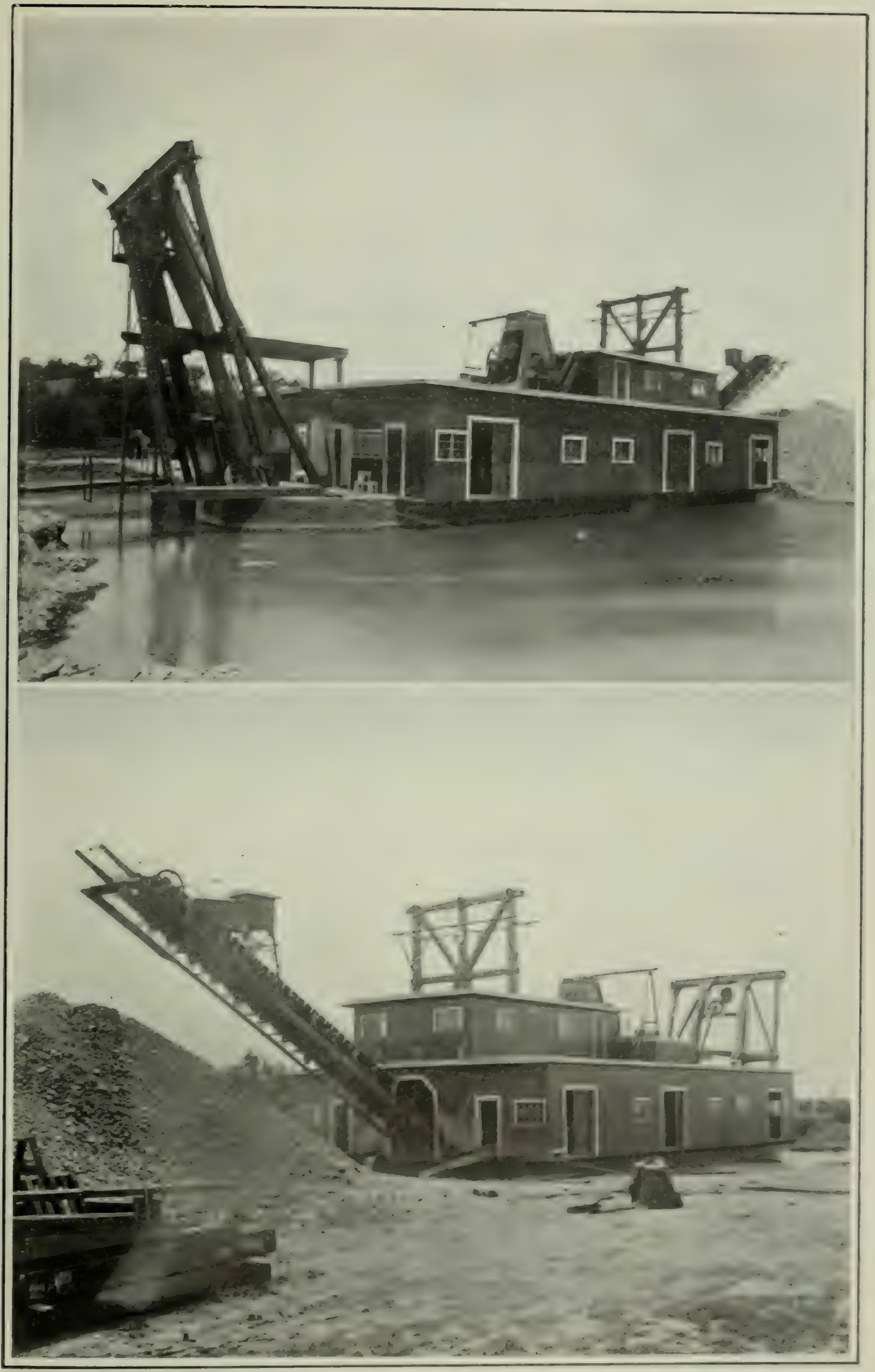
The installation shown is that supplied by the Robins Conveying Belt Co., of N. Y., to the Indiana Gold Dredging Co., Oroville, Cal. The belt is 28 in. by 88 ft. and has a capacity of 250 to 300 tons per hour.

the gold dredge and more gold taken from them than they have already yielded. The reason of this is that hand labor never touches the poorer portions of a placer, and that from the richer portions it rarely succeeds in winning more than from a half to two-thirds of the gold; whereas the dredge gets it all. If we include Spain and Egypt, which still abound in rich placer fields, to say that there are several thousand millions of golden cargo in sight awaiting the Gold Ships, is no extravagance.

Placer mining came to a stop in Egypt and Spain when their product fell to the level of hand labor; it stopped in Brazil partly for the same reason, and partly because the gravel being small and fine, the placer fields are nearly flat, and the mines are "out of grade." It stopped in California because the tailings choked up the rivers and the law courts interdicted the hydraulic process. In Australia it had almost passed the level of hand labor when the gold dredge was invented. In Alaska, though stopped in winter time for lack of running water, it is still going on during the summer time, when the streams are released from frost. In none of these countries was placer mining arrested because there was no more gold in the gravel, but for the other reasons stated, all of which are now remedied by the gold dredge. This invention supersedes hand labor by machinery; it requires no "grade" or declivity down which to sluice its gravel; it will choke no river; it needs only enough water to float itself in and to wash the gold with; and all of this water it can, and does, use over and over again. It is as much at home in the arid but auriferous deserts of Arizona, as in the golden marshes of the Feather River.

Now let us examine the mechanism of this invention, see how it works, and discuss its probable multiplication and out-turn. The Gold Ship is a dredge, which floats in a pond of its own making, a pond which accompanies it wherever it chooses to go, and which enables it to move over the land in any direction. Thus imbued with volition, it advances to the point of attack, scoops up the gravel, subjects it on its decks to the action of riffles, undercurrents, and amalgamation—indeed, to any desired process, whether mechanical or chemical—and then, having exhausted it of its gold, casts the gravel behind, and keeps on advancing, until the field before it is sifted and treated from surface to bed rock. As the ground can be thoroughly tubed and sampled beforehand, this process lifts gold mining from the category of speculative enterprises to that of a manufacturing business. The gold dredge is a gold manufactory, with an insatiable demand and assured market for its product, at the rate of $20.17 per Troy ounce fine, paid down by the mints in gold coin. No risk, no idle stock on hand, no bad debts, no commissions, brokerages, or discounts, nor no monopoly of trade, now or ever possible. An instant sale for the entire produce at a fixed price, paid in cash. Such are the incomparable conditions of the gold-manufacturing business. It goes without saying that, unless the cost of taking part in it is beyond the ordinary means of business men, such an industry will not fail to invite a vast number of participants. This contingency can be settled at once. The dredges cost from $35,000 to $50,000 each, according to size; a sum quite within the means of the average business man, commercial partnership, or small corporation.

A DIRECT FRONT VIEW OF THE RISDON DREDGES ILLUSTRATED ON THE OPPOSITE PAGE, SHOWING THE ASCENDING CHAIN OF 7-CU. FT. BUCKETS.



A RISDON GOLD DREDGE, OF 3,000 YARDS PER DAY CAPACITY

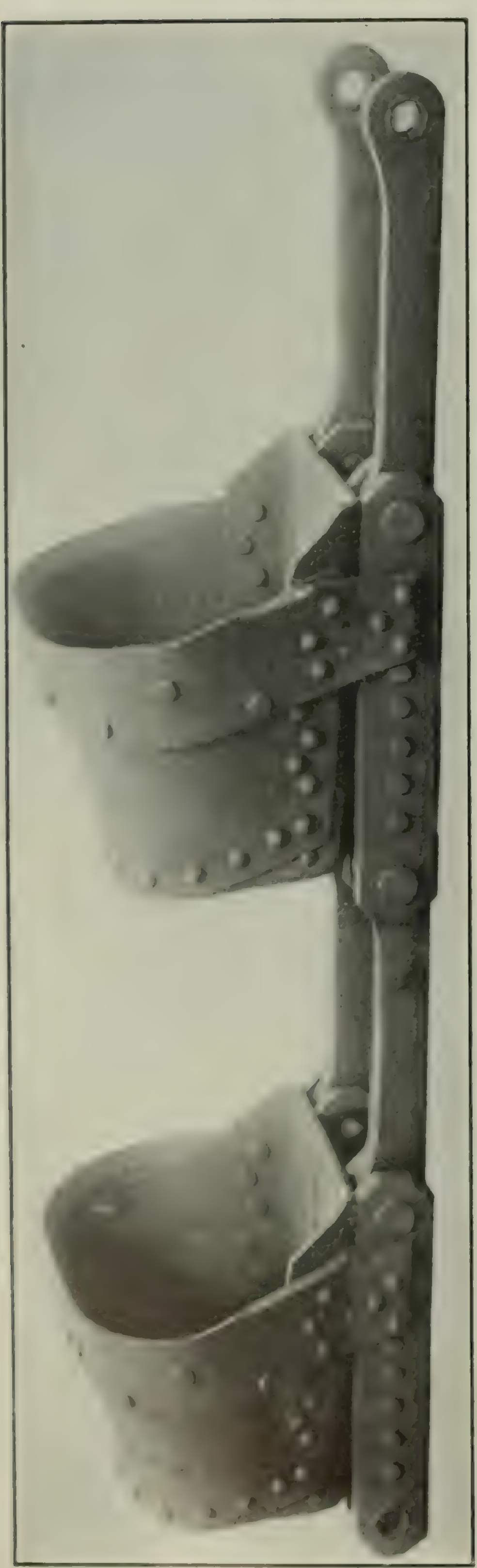
The upper view shows the ladder end, the lower the stacker. The dredge digs to 35 ft. below water line and stacks 30 ft. above it; buckets 7 cu. ft. capacity. Built by Risdon Iron Works, San Francisco, Cal.

A CHAIN OF LOADED BUCKETS EMERGING FROM THE WATER.
El Oro Dredging Co., Oroville, Cal. The buckets are of 5 cu. ft. capacity, designed and installed by the Link Belt Machinery Co., Chicago.

The gold dredge consists, first, of a wooden scow, 80 or 100 feet long, 30 feet wide, and 7 or 8 feet deep; second, of a medial upright frame, or gantry, and two side gantries, erected upon the deck, all of steel, and carrying the tumbler and countershafts; third, of a series of iron buckets lipped with steel, revolving upon a digging ladder or girder which can be adjusted so that the buckets will attack the gravel bank at any desired altitude within its range—30 feet or more below water level—and carry the gravel up to the grizzlies and screens; fourth, of a series of grizzlies and screens to sift the gravel; fifth, of a series of sluice-boxes, tables, riffles, and undercurrents, supplied with quicksilver, to wash the gravel and seize and detain the gold; sixth, of an elevator or stacking girder, which carries off the stones and coarse material directly, and the fines after they have been divested of their precious burden, depositing the entire lot of tailings 30 feet above water level; seventh, of two centrifugal pumps, delivering 2,000 gallons of water per minute into the screens and boxes; and eighth, of appropriate steam or electrical machinery to perform the entire work and keep the dredge moving on to the bank until it is entirely worked. All the metal work is housed over. These are the main features; the details can be best understood by referring to the illustrations.

Taking our figures from an actual case, No. 1, in California, the gold dredge erected on the placer ground, provided with thirty-two 5-foot buckets (technically known as a 5-foot gold dredge) cost $50,000; the boarding house, blacksmith shop, and tools cost $2,500; the working capital with which to begin operations, was $12,500; total, $65,000. The cost of operation was $1,400 per month, as follows: power, 75 horse power at $5, $375; master, $130; three winchmen at $90, $270; three deckmen at $75, $225; repairs and depreciation, $400; equal to $16,800 per annum. The annual work done amounted to 10 acres, 30 feet deep, say 500,000 cubic yards, yielding 20 cents per yard, total, $100,000. The profit was therefore $83,200 per annum, or about 128 per cent. on the entire capital invested. This showing is regarded as sufficiently attractive to, in time, turn the eyes of the commercial world towards this extraordinarily lucrative industry. Twenty-cent gravel is not uncommon; neither is 40-cent gravel; there are billions of cubic yards of it to be obtained in

BELT CONVEYOR RUNNING ON THE STACKER OF A GOLD DREDGE.



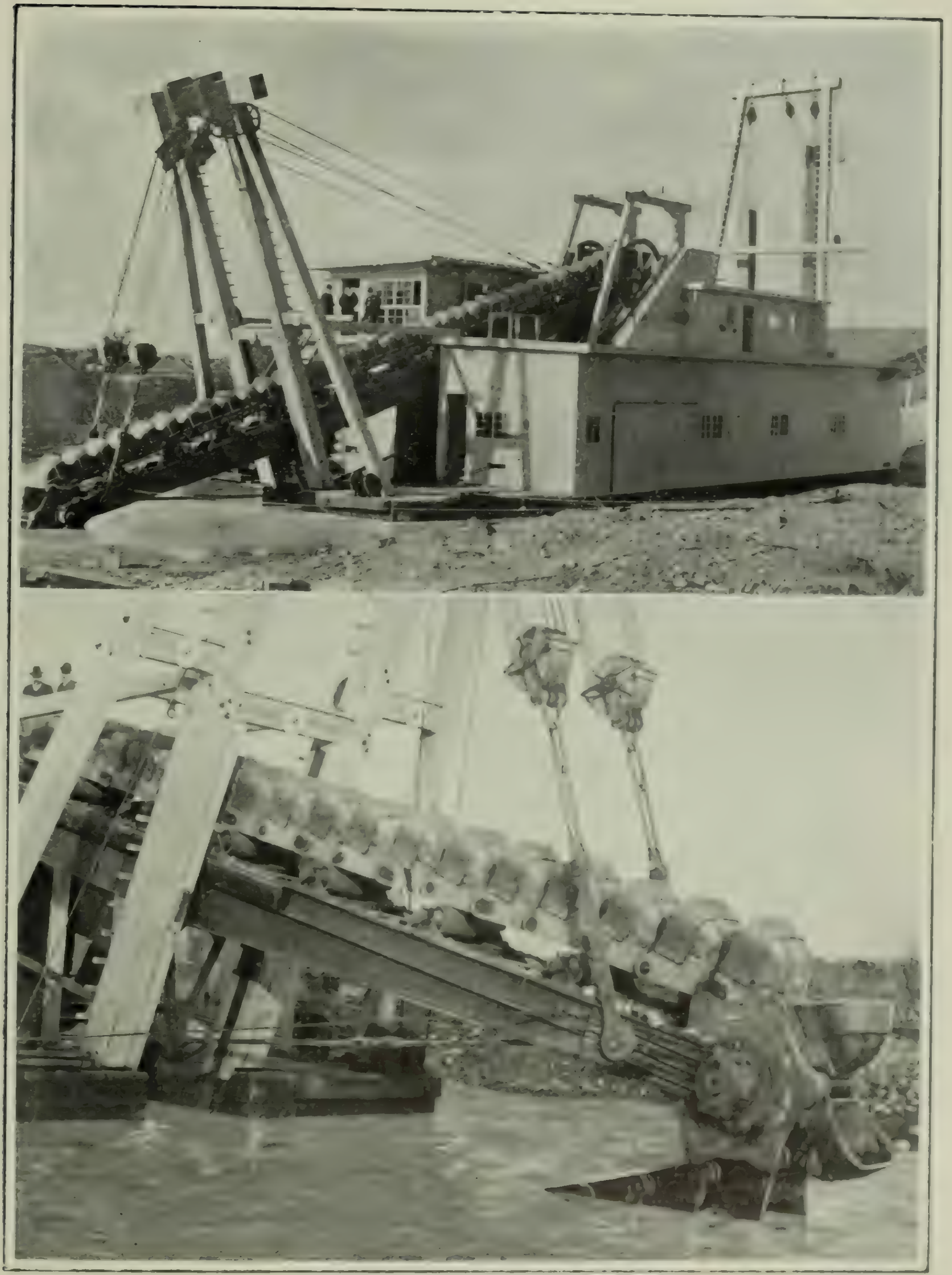
FORGED-STEEL BUCKETS FOR GOLD DREDGE.
Designed by A. W. Robinson.

several countries — Brazil, for instance — and practically for the nominal cost of registering locations.

The theoretical capacity of the 3-1/4-foot dredge is 85 to 120; of the 5-foot dredge, 130 to 190; and of the 7-foot dredge, 185 to 265 cubic yards per hour; while the actual work will depend partly on the nature of the gravel and partly on the skill of the winchman.

Case No. 2 was a 3-1/4-foot dredge, which, during 6,933 possible hours, actually ran 5,752 hours and lifted 297,220 cubic yards, bank measure. The actual expense was:—for wages, $8,400; repairs, $2,250; fuel, $2,660; total, $13,580, or about 4 1/2 cents per cubic yard. Through an economy since perfected, this has been reduced to 3 3/4 cents per cubic yard; so that gravel containing so little as 5 cents to the cubic yard will pay to work, and yield a sure profit of 33 1/3 per cent. In using steam machinery, the 3-1/4-foot consumes about 2 1/4 and the 5-foot dredge about 4 cords of wood per diem, for fuel. Theoretically, the cord measures 8 by 4 by 4 feet; but practically, especially in mining regions, it is 6 by 4 by 4 feet. The ton means 2,000 pounds.

The weight of the machinery necessary to construct and set up a 3-1/4-foot dredge is about 120 tons, including all the bolts,



DREDGE CALIFORNIA NO. 2, BOSTON & CALIFORNIA DREDGING CO., OROVILLE, CAL.

A 5-cu-ft. dredge of Bucyrus build. The lower view shows in detail the chain of buckets. They have manganese-steel lips and bushings, cast-steel bases, forged-steel pins. The tumblers are of cast steel, with manganese-steel wearing plates. The ladder rollers are manganese-steel. Manufactured by the Taylor Iron & Steel Co., High Bridge, N. J.

screws, spikes, nails, and other metal-ware necessary for the purpose; in short, everything except the lumber, or woodwork. The quantity of lumber required equals 50,000 to 60,000 feet, board measure, and weighs about 75 tons. The machinery for a 5-foot dredge weighs about 200 tons and the lumber about 150 tons. The repairs which might be needed for the smaller machine can be executed by a blacksmith; while those on the larger ones would need the aid of a machine shop. The freight from the American port of shipment depends, of course, upon the port of debarkation and distance to the placer ground. Insurance is equally indeterminate. In most countries, machinery to develop the mines is free of duty, and the mines themselves are free of taxes or other dues. With these details before him and the services of an experienced placer miner to test and afterwards to work the gravel, any merchant, with the requisite capital, can at once become a profitable producer of gold.

Like most other inventions, the Gold Ship is a development. A gold dredge was used on the Magdalena River twenty years ago; the device was further developed several years later in New Zealand; it was brought almost to perfection in California; at the present time, a dozen machine shops, scattered all over the United States, are rivalling one another in turning out a more and more perfect dredge. The home demand for these machines is so urgent that but few have as yet been shipped abroad; yet several of them have already gone to South America and several more to Europe. The present rate of out-turn is about one machine per week; in the course of a few years it will be one per diem; in ten years it will probably be ten machines per diem. When this takes place, and perhaps before it, the world's production of gold, even should the quartz mines yield no more than at present, will be two million dollars a day.

When, during the sixteenth century, the mines of America threw upon the world a vast and unlooked for supply of the precious metals, the result was to impart a sudden and tremendous stimulus to production, invention and discovery. The Halcyon Ages dawned; and Europe rose at a bound from penury, ignorance, and retrogression, to comfort, enlightenment, and progress. That such may be the bright future before us of today, nothing seems wanting but to let the Gold Ships pursue their eventful voyages in peace.

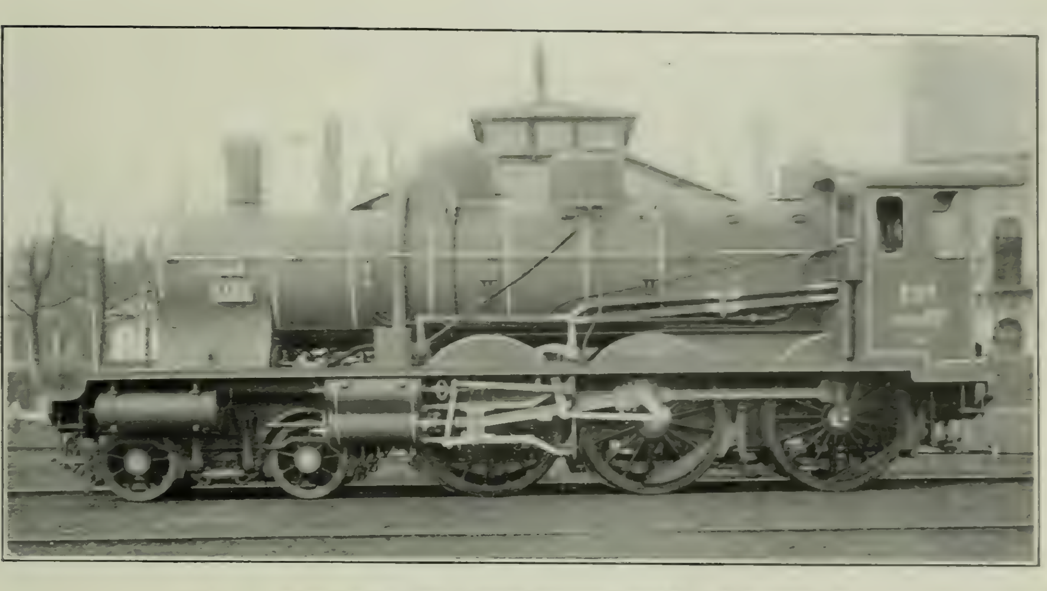


FIG. I. SPECIMEN OF LOCOMOTIVES BUILT AT EPERNAY.

Fast-freight or mixed-service engine, "Est" type; four cylinders, piston valves to all; Walschaert-Heusinger valve gear; air brake on front truck.

A LARGE LOCOMOTIVE BUILDING AND REPAIR WORKS IN FRANCE.

By Charles R. King.

The railway locomotive shop offers many opportunities for the application of the latest ideas in tool practice and general management, and Mr. King's articles would be widely interesting if only for the examples of this kind they furnish. The recent International Railway Congress, however, has greatly stimulated the home interest in foreign practice, and as a most timely contribution to this important study we are glad to offer these two papers, describing in valuable detail the methods and the work of one of the most advanced establishments on the Continent. The first of the group, presented in this issue, deals chiefly with the general arrangement and equipment of the works; the following section will review the locomotive-erection and general machine-shop practice of the Epernay shops.—THE EDITORS.

AT a time when the locomotives of France are attracting the attention of American and English constructors, some description of an important railway works devoted to the making and upkeep of such machines may have especial interest for mechanical engineers.

The works of the Chemins de Fer de l'Est are especially selected for mention here, for the reason that while nearly all locomotive-construction for French railways is in the hands of private firms, this railway company has for a great number of years past built many of

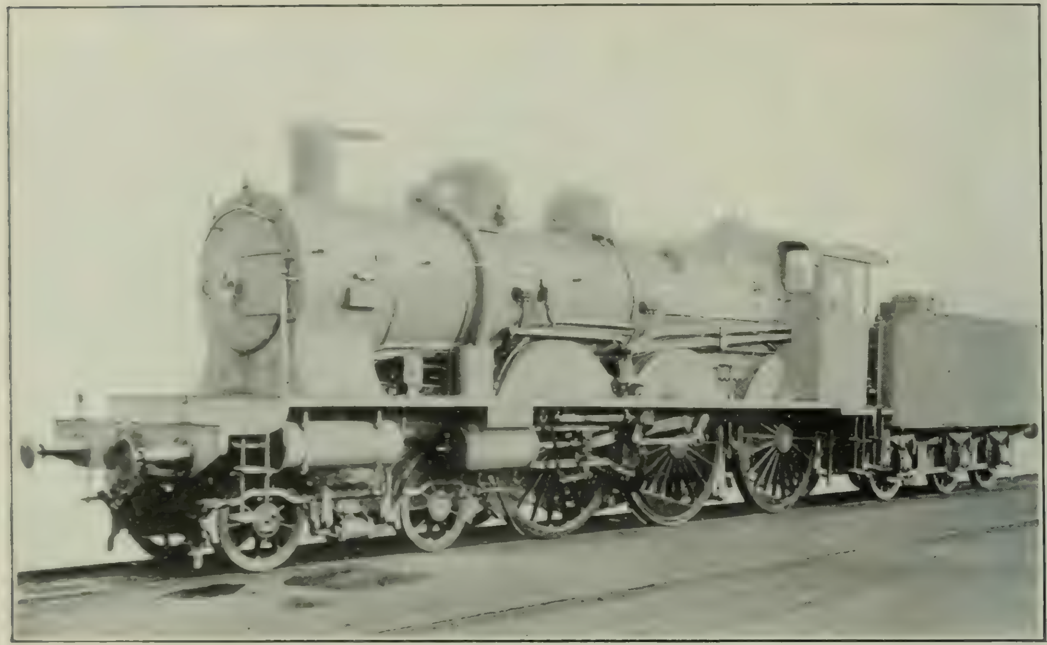


FIG. 2. "EST" TYPE 6-10 COUPLED LOCOMOTIVE.

Four-cylinder compound, "Est" system; de Glehn starting valve.

its own locomotives, and while keeping abreast with modern developments has maintained more individuality for its mechanical productions than other French lines. Here it may be remembered that the heads of the "*Materiel et Traction*" of the Est are engineers of great ability who have been known throughout the railway world for a long term of years—that is, M. Salomon and his chief mechanical engineer, M. Flaman—men of that genius and high cultivation which appear to be characteristic of chief railway engineers in France.

The company's works are situated at Epernay (Marne) on the main line between Paris and Nancy. They are interesting both for their extent and for the wide range of work done in the shops. Although the shops themselves are not all wholly modern, as are those of the Nord company at Hellemmes-lez-Lille (Nord), the all-important matter is that the tool equipment is modern. With the "Est" all locomotive building and repairs are concentrated at Epernay, whereas the "Nord" has a central works at Paris-la-Chapelle where a certain amount of heavy work is done, including an occasional "type-locomotive." On the contrary, the Central works of the Est at Paris-Pantin are principally confined to car repairs, the main car-building works being situated at Romilly on the Paris-Belfort trunk line.

The extent of work done at these Epernay workshops may be gathered from the fact that the number of locomotives to keep in repair (at the beginning of the year 1904) is 1,422—of which number there are 212 four-cylinder locomotives of the 6-10 connected type, some 50 of which are employed for freight haulage. A view is given in Figure 1 of this mixed-service type having a piston valve for each of the four cylinders, and built at the Epernay works, besides one of the most recent 6-10 connected type for the fastest trains also built at Epernay (Figure 2). This latter, it will be seen, has flat slide valves; but later engines are to have piston valves also.

The total mileage of the company's locomotives in the year 1903 was 36,370,000 miles, and the number of locomotives which entered the shops for important repairs was 108—all small jobs being done as usual in local running-house repairs sheds. The average time-duration, out of the total number of repairs executed, is usually from 4 to 5 months.

The number of new engines built in one year (1903) is 30. The number of workmen employed is 1,500. The motive power required for the works will be found described in the details hereafter given.

As usual with a great many European locomotive works which are not entirely of modern origin, there are at Epernay various buildings which have been built in accordance with the necessities of the period, each one having been all-sufficient in its own time; but as the steam locomotive grows in size each year to answer the requirements of ever-increasing populations, even comparatively modern works have been outpaced by its bulk and its weight. In general, it is the erecting shop which receives the first care for the necessary enlargements—and this has been the case at Epernay.

The situation of the workshops is between the Epernay station and the river Marne; but before proceeding to the new erecting shops we may look into the boiler house and power room which, though not remarkable for their size, are interesting for their plants. In fact, just before entering the boiler house, the visitor's attention is attracted by the sight of long banks of roasted coal or cinders lying outside its doors. These are the screenings of locomotive smoke-box residues which are always used for generating the power required at the works. One locomotive, on average, yields 660 kilograms (1450 pounds) of these screenings per month, but the calorific value of this product does not appear to have been so far tested. The analysis, however, shows its contents to be as follows, as compared with the ordinary coal used—which latter is a small or slack coal of "*demi-maigre*" quality capable of generating 6 pounds of steam per pound of fuel:—

	Smoke-box sweepings.	Fine coal (slack).
Carbon	66	65
Volatile matter	4	15
Ash	22	18
Water	8	2
	100	100

The smoke-box residues generate 3 1/2 pounds of steam (effective) per pound of fuel, after making deduction for the amount of steam used for the furnace blower jets, and this result, it may be remarked, is at least equal to that produced by the poorer kinds of the lignite, or brown coal of Bohemia.

In the boiler house there is one row of six water-tube boilers built by the Epernay works, fitted with moveable tubes on the Berendorff system, this form of generator having two parallel boilers at the base connected by straddled rows of side tubes to a steam cylinder (usually misnamed a "drum") at the apex. The boiler pressure is 108 pounds per square inch. The annexed view, Figure 3, conveys some idea of the type of generator employed. The three farthermost boilers were, at the time of making this photograph, fed with ordinary coal, and the three nearest boilers were fed with locomotive smoke-box screenings, the steam pipes for blowing the grates being visible in the details. The grates, of an Austrian system (the Kudlicz), are cast-iron panels, the air spaces being round conical holes and the ash pan beneath them being perfectly air-tight. In the front of the ash pan there are eight steam tuyeres or jets, that is, four beneath each lower barrel of the generator. The steam blast entering below the grate maintains the cinders or roasted coal in a state of high incandescence. From 5 to 10 per cent. of the steam produced is used for blowing the grates. At present (1904) smoke-box sweepings have entirely replaced the coal hitherto employed. The grate area of each boiler is 33 1/2 square feet, and the heating surface 1,300 square feet. The evaporation is from 2,000 to 2,400 litres per hour. The boiler-house chimney has a height of 140 feet and a diameter inside of 6 feet 6 inches, its foundations being built on piling.

In the adjoining power house the engine is a single-expansion condensing machine of Corliss type, made by Lecouteux & Garnier, developing 250 horse power and having an efficiency of one horse power per hour for 16 1/2 pounds of steam. Its cylinder is 24 inches diameter, with a piston stroke of 4 feet, and is steam-jacketed. When working at full load the cut-off is 1/16. The expansion valves provide admission up to 8/10 cut-off point, when required to develop

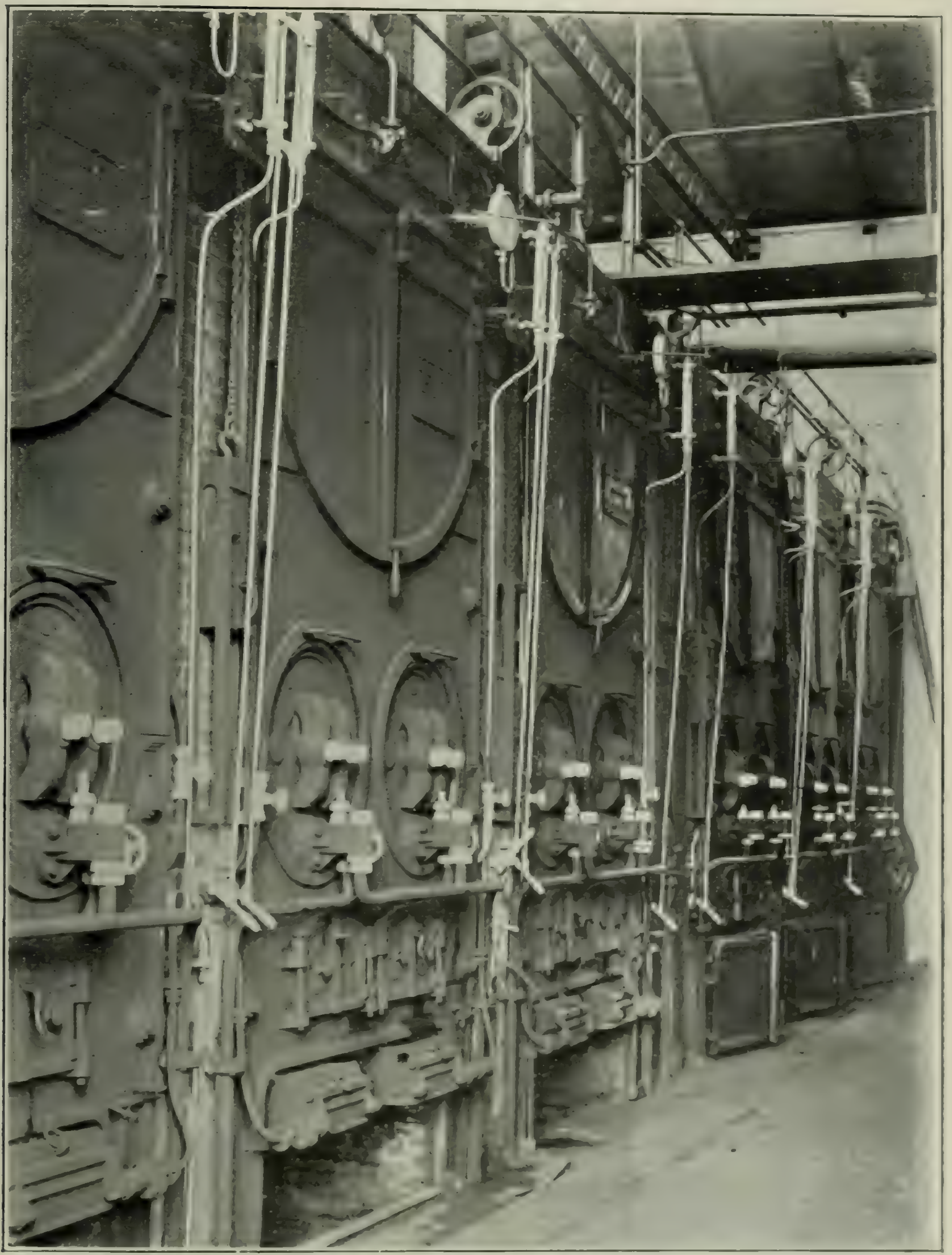
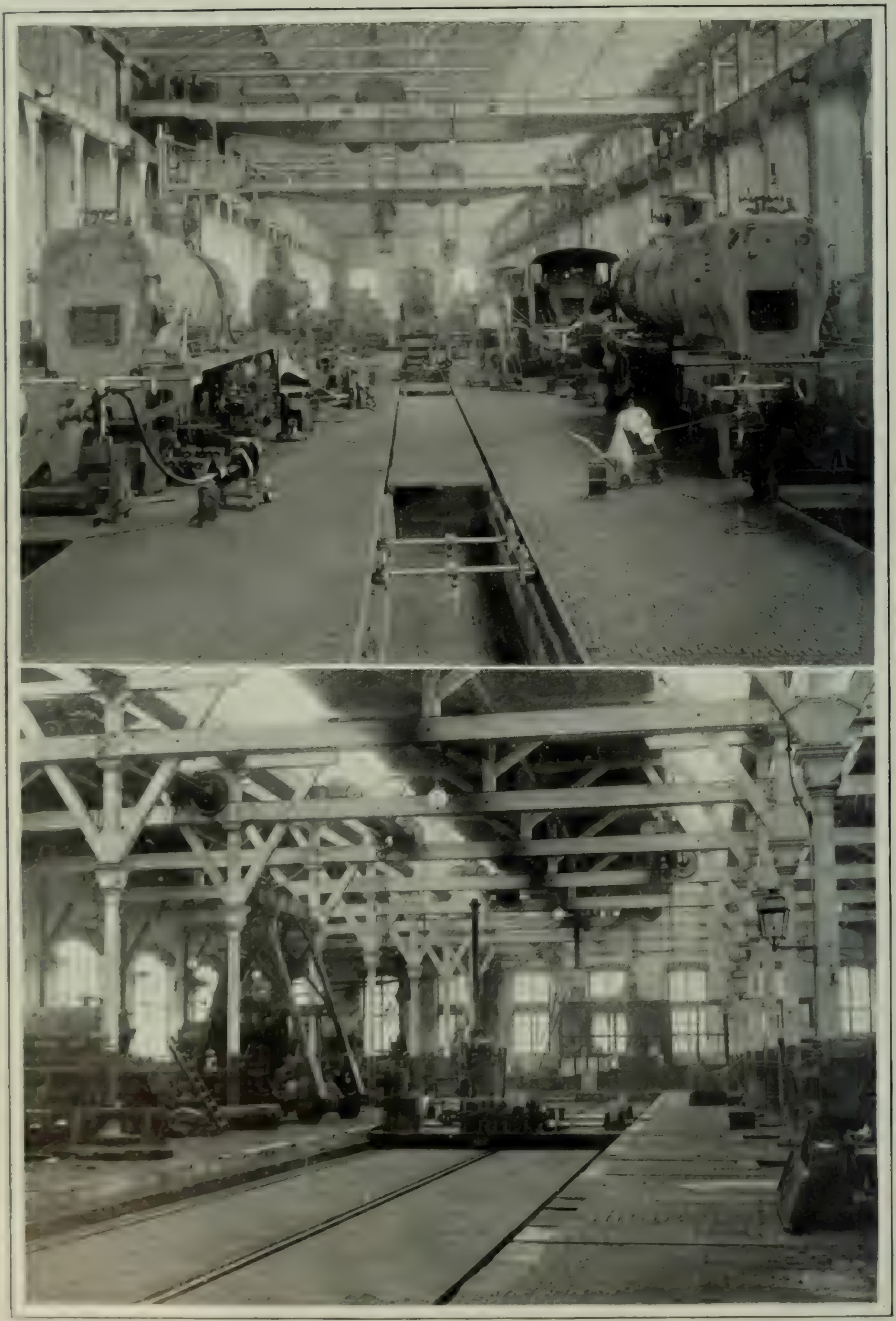


FIG. 3. THE BOILER PLANT.

The three boilers in the background are fed with coal, the three in the foreground with locomotive smoke-box screenings.

more power or when working non-condensing, as in the case of stoppage of the condenser for any reason. The steam condensed in the jacket is drained direct to the feed water, which latter supply is derived from the river Marne, 180 metres distant. The pumps, driven from the engine main shaft, have a capacity of 9,000 litres per hour—



FIGS. 4 AND 5. FIGURE 4, BELOW, IS THE ERECTING SHOP WITH DEPRESSED TRANSFER WAY. FIGURE 5, ABOVE, SHOWS A LONGITUDINAL TRAVERSER IN THE ERECTING SHOPS.

sufficient for all requirements of four out of the six boilers in service at one time. The boilers are provided with two Sellers injectors (9 and 9½ centimetres) with a capacity of 9,000 litres per hour. The temperature of the feed water is 30 to 40° Centigrade, but in winter-time the heating-coils in the erecting shop are drained into the feed water and its temperature is thereby raised to 70 and 80°; the feed is then worked by a Blake double vertical pump, fixed near to the boilers and having a capacity of 6,000 litres per hour.

The engine fly-wheel has a diameter of 16 feet 4 inches; it has twelve drive-rope grooves and turns at 60 revolutions per minute. It has a barring attachment for starting it from dead centers. Being situated next the new erecting shop, direct transmission by belt is employed for the heavier kinds of tools usually necessary in such a department, and as these are grouped near to the power house, a minimum of shafting is necessary.

Electrical Power Transmission.—In considering the advantages of electrical transmission, it was estimated that with new and well made motors the electrical output at full load would be 0.9 and the effective electrical transmission $0.9 \times 0.9 = 0.81$, while with a small load and with machines of low power the efficiency would rarely be less than 0.5. The saving to be effected by electrical transmission would amount to 17 tons of shafting and the power necessary to drive it, light load or heavy load, all day long. The machine adopted for the service is a six-polar dynamo of 600 amperes at 110 volts tension, variable by rheostat between 100 and 120, and having an efficiency of 92 per cent with full load.

Erecting Shops.—The several views given show the old as well as the modern erecting works. The old one, built in 1877, Figure 4, has a traversing pit with steam traverser, the inconvenience of which arrangement is that the space allowed for the length of locomotives in the various bays cannot always be economically utilized, by reason of the widely-varying lengths of the different types of locomotives to be housed. The traverser pit is also an impediment to the workmen, who have to cross it frequently, and when carrying pieces which, though heavy in themselves, are too light to warrant the use of a crane. Of course a shop of this type need not have this objection of a sunk floor, for there are many modern shops with a level floor where an electric floor traverser is used, this latter being of course raised and provided with suitable inclined ends for hauling aboard the machines to be transferred. The old shop accommodates sixteen locomotives in eighteen bays (two bays being reserved for semi-portable engines and boilers), while the new one has a capacity for fifty-six locomotives—the total therefore of the two shops being seventy-two locomotives. The new shops, Figure 5, were designed by the Est permanent-way department, partly upon the model of those already existing at Romilly, and were built in 1894. They are constructed entirely of steel and of fire-proof materials; their roofs, of lean-to or shedding pattern, being in two spans and lighted exclusively from the north side. Each of the two bays so formed comprises three tracks, two for erecting and one through line for transits. The side lines accommodate a total of forty locomotives, and the two central lines in case of necessity can also be used for work of a temporary character and so accommodate sixteen locomotives.

Two cranes of 30-tons (metric) lifting power serve each of the two bays and are sufficient to lift a single locomotive of the present "Est" type from one track to another, or out of the shop when the engine is not loaded up with all its fittings (see view Figure 6). These cranes, by Merlot, are driven by steel-wire cables having a hemp core. All their gears are controlled from the usual operator's platform, but as the work done consists largely of repairs it is not always convenient to keep an attendant there for that purpose; consequently hand chains are also provided, by which the raising, lowering, and traversing motions may be controlled from the shop floor itself. Pinions are used throughout for driving gears, in place of worm screws which would absorb much more power. Gearing or ungearing of the pulley is effected by shifting a belt from a fixed to a loose pulley, this change being operated by means of a small auxiliary worm screw driven by cord. Changes of speed can also be effected from the floor, the chain for this purpose passing over a fixed pulley on the crane beam. The raising and lowering gear includes a special ratchet device inside the pulley of the grab hooks, the brake therein being automatic, while the controlling brake-lever of the crane renders the ratchets, or safety clutches, inoperative only so long as the grab block is on its downward course. Both cranes can be operated together as though one piece, and all the fast movements can be employed simultaneously for loads of up to 15-tons weight.

The lineal speed of the cables is 15 metres per second, the traveling speed of cranes 8 to 20 metres per minute, the traversing-crab speed is 4 to 12 metres per minute and raising and lowering speeds, 1 to 2½ metres per minute. The total crane travel in the shop is 156.4 metres. The crabs have a traversing movement of 11.5 metres and the control-chain carriers, or trucks, have a travel of 5½ metres.

These trucks are provided one for each gangway on each side of the central track, and their chains always hang within reach of the workman or in such position as enables him to get the best view of the piece that is being lowered into place. The clear height of the crane beam from the floor is 7.6 metres.

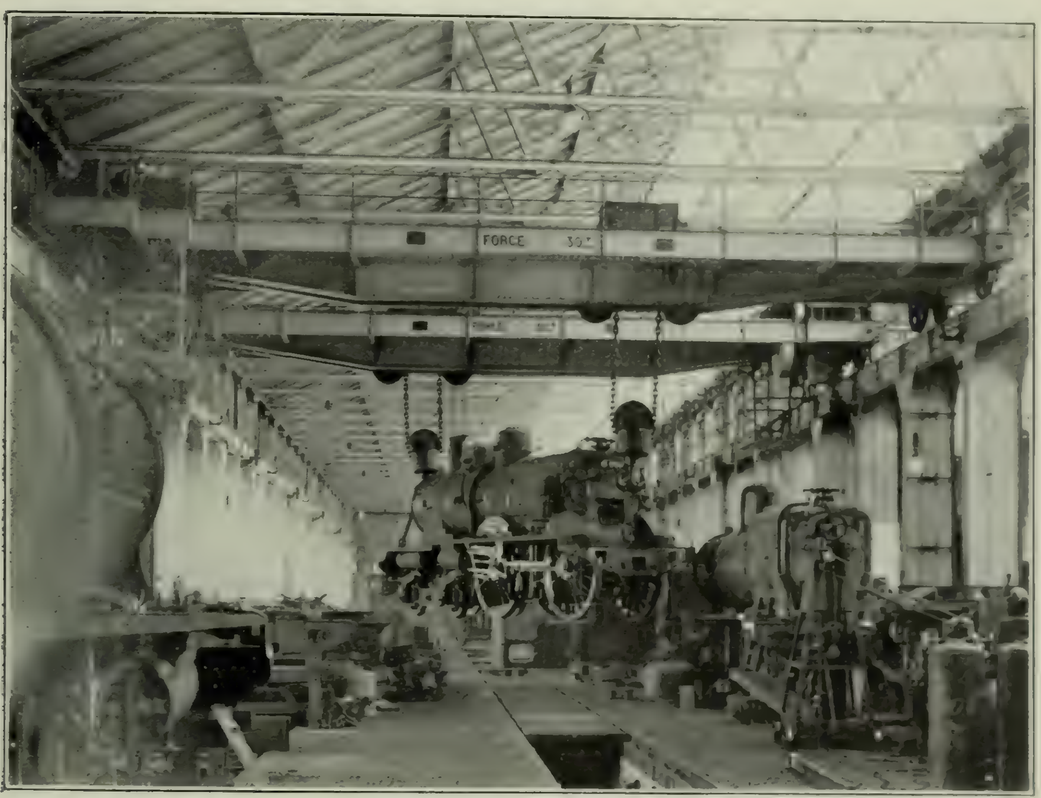


FIG. 6. TWO OVERHEAD TRAVELING CRANES CARRYING A LOCOMOTIVE IN THE ERECTING SHOP.

Portable rolling frames with electric motor for operating drilling tools, etc., are shown in the right foreground.

The forms of transmission employed in the shops are belting, cable, compressed air and electricity; hydraulic transmission having a very limited application. Transmission of current to small tools is effected by wires laid in conduits along the side walls of the track pits, the number of openings provided for the wire connections to the tools being very large throughout the whole length of the shop. As the number of portable electrically-driven machine tools used at these workshops is very large, little more than a summary notice of them can be given here. There are forty-four complete sets of portable electromotors aggregating 128,142 watts or about 174 steam horse power. When hauling cold locomotives about the shops and where lifting is not necessary, electric winches are used, these being made fast to the rails by suitable grips on the main frame of the appliance and upon which latter is mounted a motor of about 4 horse power, speed being reduced from the motor shaft to the pinion shaft of the winch by means of a belt (see Figure 7).

For drilling purposes the types of machines are many. Those for stay-bolt holes in fire-boxes are very small, compact machines readily fixed to a wooden beam bolted across the crown of a fire-box. By means of a long radiating arm with telescopic shaft, any part of the side sheets or boiler head can be reached very conveniently. Such a machine may be noted in the view Figure 8. The same pivoting arrangement, but without the motor case as a means of support, can be attached, inverted, to a roof-girder or wall-plate, and then serves also for drilling crown stays. Drilling, reaming, tapping, and screwing in bolts is the common work of these machines, both in the boiler shops and erecting shops. They are fitted with Gramme motors of 2.3 kilowatts or about 3 horse power.

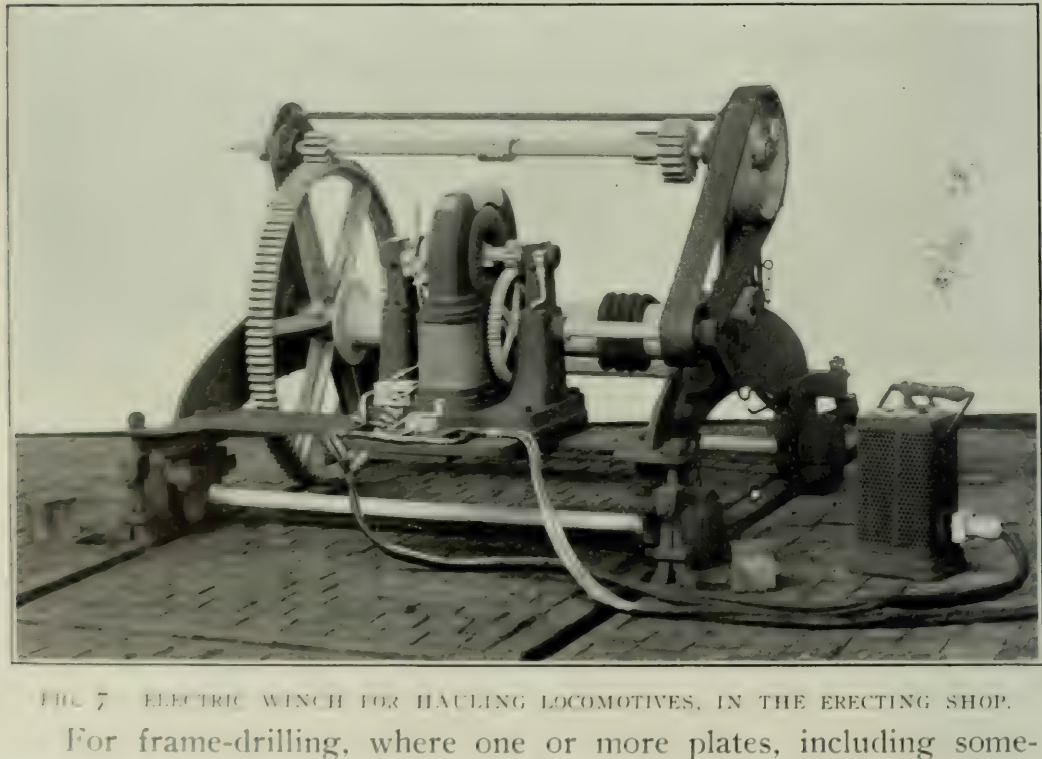


FIG. 7. ELECTRIC WINCH FOR HAULING LOCOMOTIVES, IN THE ERECTING SHOP.

For frame-drilling, where one or more plates, including sometimes the horn-blocks or "pedestals," are to be pierced, different forms of fixings are employed for the tool in order to suit the nature of the work in hand, and as may be discerned in the views Figures 5 and 8, the transmission being either rigid or elastic and the motors mounted on a two-wheel barrow or upon four rollers. These all have Gramme motors of 3 horse power.

A universally handy appliance for frame-drilling and for drilling certain parts very difficult of access, consists of a portable frame or tower on wheels, to the base of which is attached the electromotor, while the head carries the shafting and pulleys for belting, any desired variation of speed being effected through grooved pulleys and driving cords. This rolling stand may be used for any other drilling rigs that are not provided with their own special motor. This may be seen in the middle of the view Figure 5 and in the foreground of the view Figure 6. The motors employed are of Postel-Vinay type, of 4.6 kilowatts or 6¼ horse power.

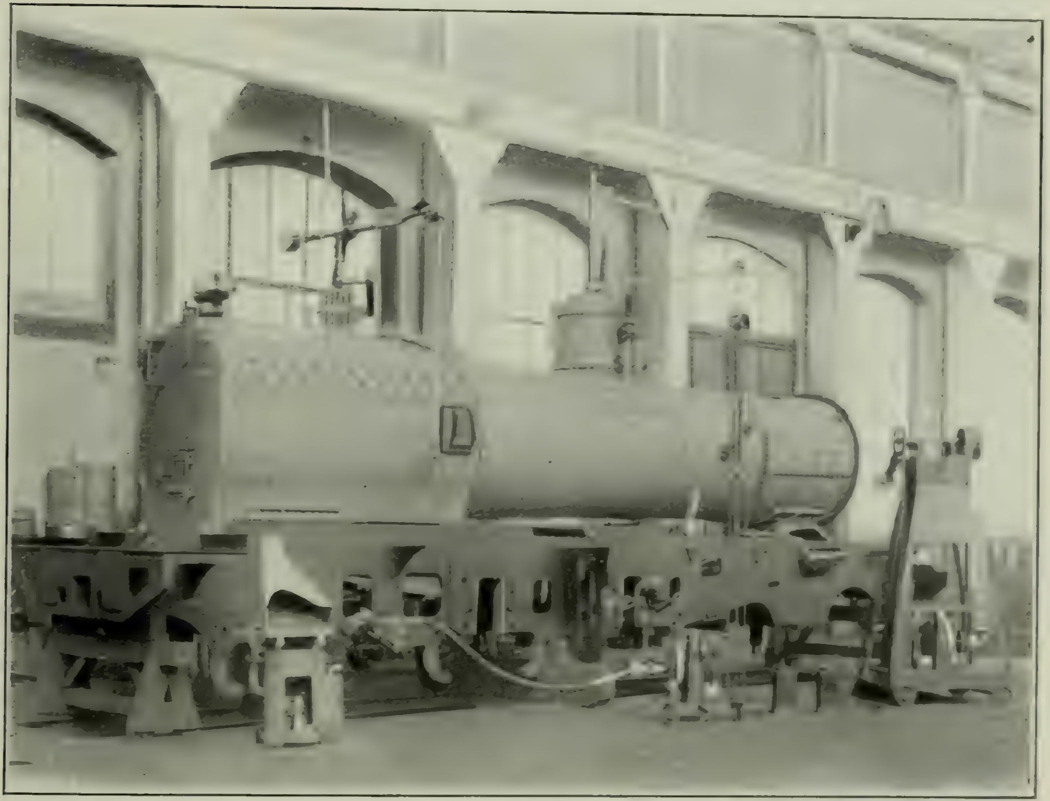
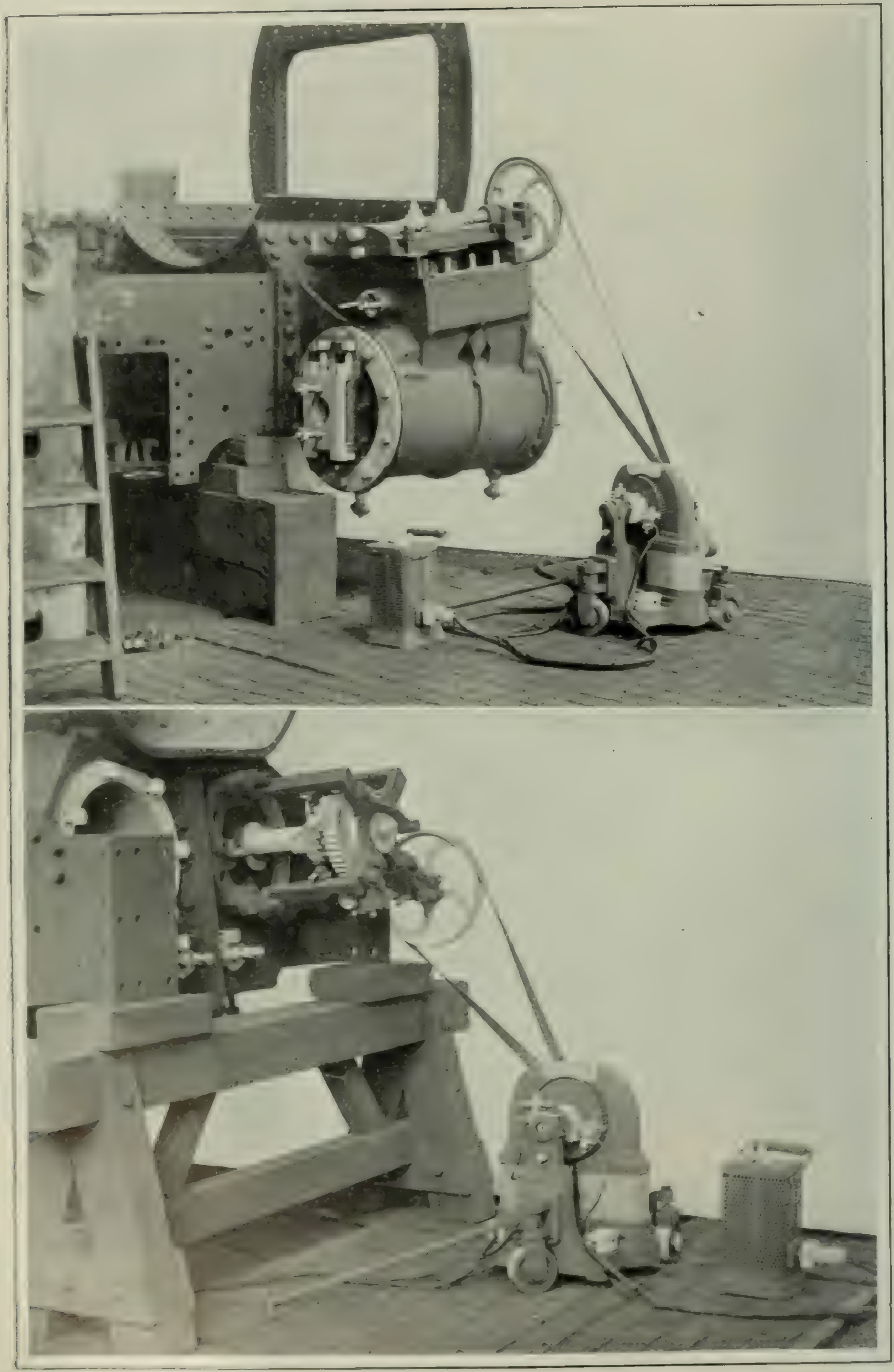


FIG. 8. THE ERECTING SHOP. ELECTRICALLY DRIVEN PORTABLE MACHINE TOOLS AT WORK.

The drilling machines with long radiating arm and telescopic shaft are adaptable with great convenience to drilling any part of the side sheets or head.

For reboring a cylinder or surfacing a worn valve-seating, the appliances shown in Figure 9 and Figure 10 are used. The cylinder borer is secured by means of the usual cover bolts in the place of the covers themselves, the mandrel imparting the rotary movement to the boring head, while two fine screws, passing through the latter and revolving with it, give the necessary feed to the cutters. This is shown in Figure 9, wherein it may be noted that the boring head is already advanced two clear inches into the depth of the cylinder. This rig is driven by a Gramme motor of 3.3 kilowatts and a similar ma-



FIGS. 9 AND 10. FIGURE 9, BELOW, ILLUSTRATES THE OPERATION OF CYLINDER BORING BY A PORTABLE TOOL. FIGURE 10, ABOVE, SHOWS PORTABLE APPARATUS FOR FACING THE VALVE SEATS IN PLACE. BOTH TOOLS ARE ELECTRICALLY DRIVEN.

chine serves for the valve-seating milling-tool shown in Figure 10. In this case the feed is provided through the screw and pinion gearing on the main shaft, which carries the driving pulley connected by belt to the motor shaft.

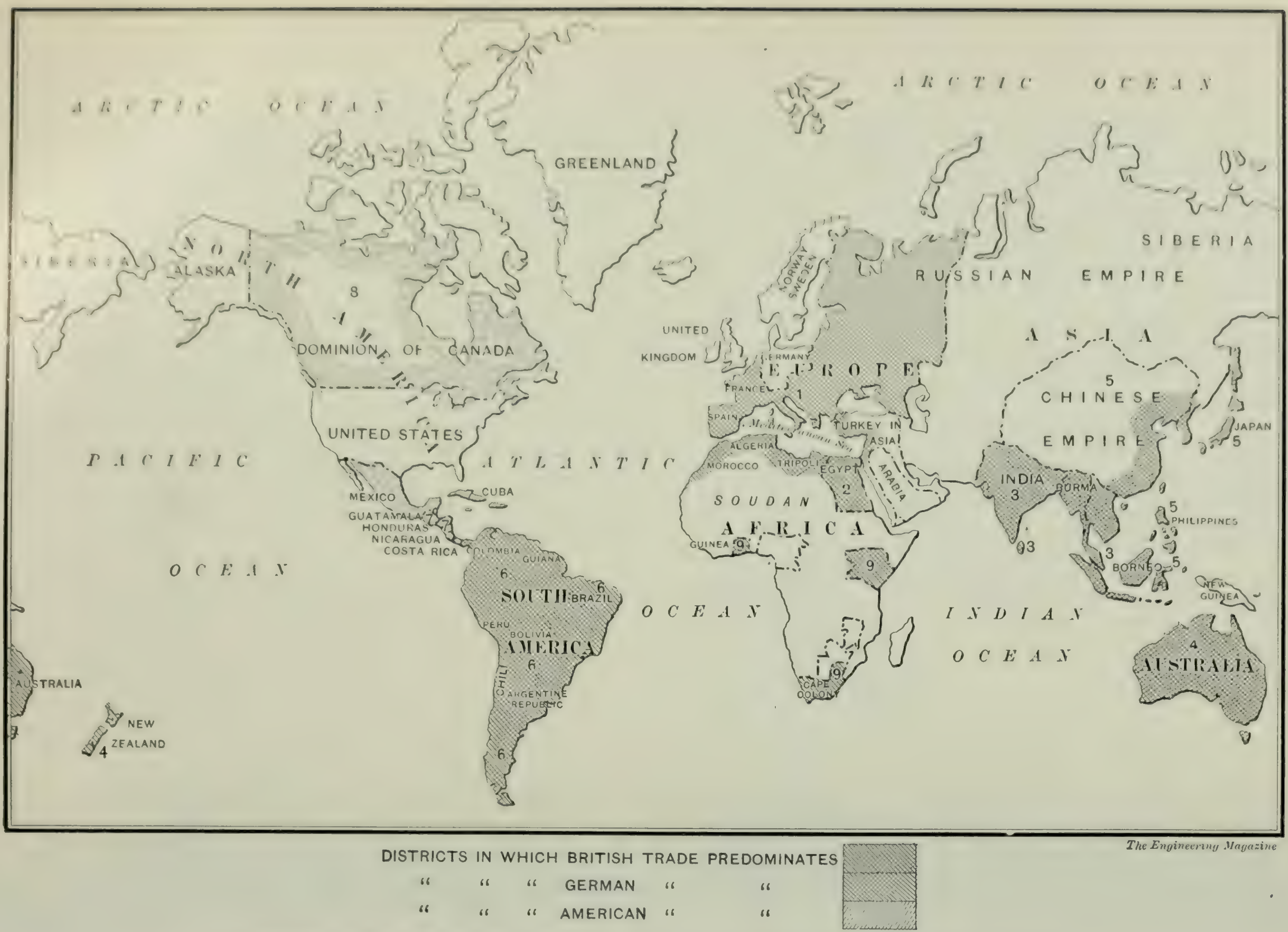
This reboring machine can, on an average, finish a cylinder complete within five hours, while the valve-seating miller can dress up a seat anew in about four hours upon average.

In the same erecting shops the portable forges are provided with electromotor-driven fans as shown in the view Figure 8. Fixed to brackets bolted to the roof columns there are about eight electromotors of 2.8 kilowatts for driving, by belt, double-head emery surface-grinders, and three others for tool-grinding wheels. All the motors in the shops have a commutator carrying a metallic rheostat only serving for purposes of starting the machine. The portable machines, however, have pinions for reducing the speed to 300 revolutions per minute on the tool-shaft, but the speeds can be further varied by rheostat to suit individual tools or the particular work in hand.

In the end of the same shop the heavy tools provided are a Grafenstaden radial drill of 1.7-metres sweep; a Bouhey borer and drill; a Warrall pedal drill; a Ducommon planer; two Marsden shapers; a Bouhey circular shears; two Nathan-Khan stone-grinders —one "edge" and one "face"; a Root's blower for a double forge, and various smaller tools.

The fitters' benches, arranged around the sides of the shop, are provided with nettings about 80 millimetres high for the purpose of arresting flying pieces of metal. Racks are provided where the cutting tools belong to each machine are placed after being cleaned and washed.

A following article will take up the methods used in locomotive erection in the Epernay shops, and the general machine-shop management and administrative policy of the works.



The Engineering Magazine

A GRAPHIC CHART OF BRITISH, GERMAN, AND AMERICAN DOMINANCE IN EXPORT TRADE.

The trade-zone numbers correspond with those used by Mr. Digby in the body of his article.

ENGINEERING EXPORTS OF GREAT BRITAIN, GERMANY AND THE UNITED STATES.

By William Pollard Digby.

II. RELATIVE PROMINENCE IN THE MOST IMPORTANT TRADE ZONES.

Mr. Digby's analysis of trade supremacy began last month, with a general review of export figures. It will conclude next month with a forecast of future changes. Throughout, it gives a remarkably graphic idea of the world-wide markets for engineering manufacturers.—THE EDITORS.

ADJOINING the European countries, which were treated as a composite trade zone in the last number of THE ENGINEERING MAGAZINE, is a group of countries comprising northern Africa, Egypt, Algiers, Tripoli, Morocco and Asiatic Turkey, ranged around the southern and eastern Mediterranean seaboard. This zone, while covering a larger area, has but a sparse population, and offers only a limited market to the engineering manufacturer. Egypt, whose resources are now being developed in a great number of directions, makes the chief purchases. Continental countries are regarding this zone very jealously, and there are the elements of international complications over the "pacific penetration" of Morocco, or the apportionment of the dominions of Abdul Hamid should the Turkish Empire go to pieces. Whether any of these regions are potential Egypts remains to be seen. Judged by the present amount of trade in certain parts of this region, it seems strange that so much attention should be given to the virtual staking out of claims for posterity. Surely no other power hopes to emulate British performances in Egypt, a country which, at one time the granary of the world, seems likely to regain a portion of its past eminence by reason of the fruits of the Nile barrage.

The following are the value of the exports from Great Britain, Germany and the United States to the countries mentioned in this region:—

EXPORTS TO ZONE 2.—SOUTHERN AND EASTERN MEDITERRANEAN SEABOARD

Year. Ex	1899.	1900	1901	1902	1903
	In thousands of pounds sterling				
United Kingdom	891	964	849	971	927
Germany	...	277	385	430	575
United States	35	43	123	29	23

The British predominence is due largely to the extent of the exports to Egypt. The chief items of the British and German trade to Egypt are shewn in Diagram No. 1, which shews a decline in

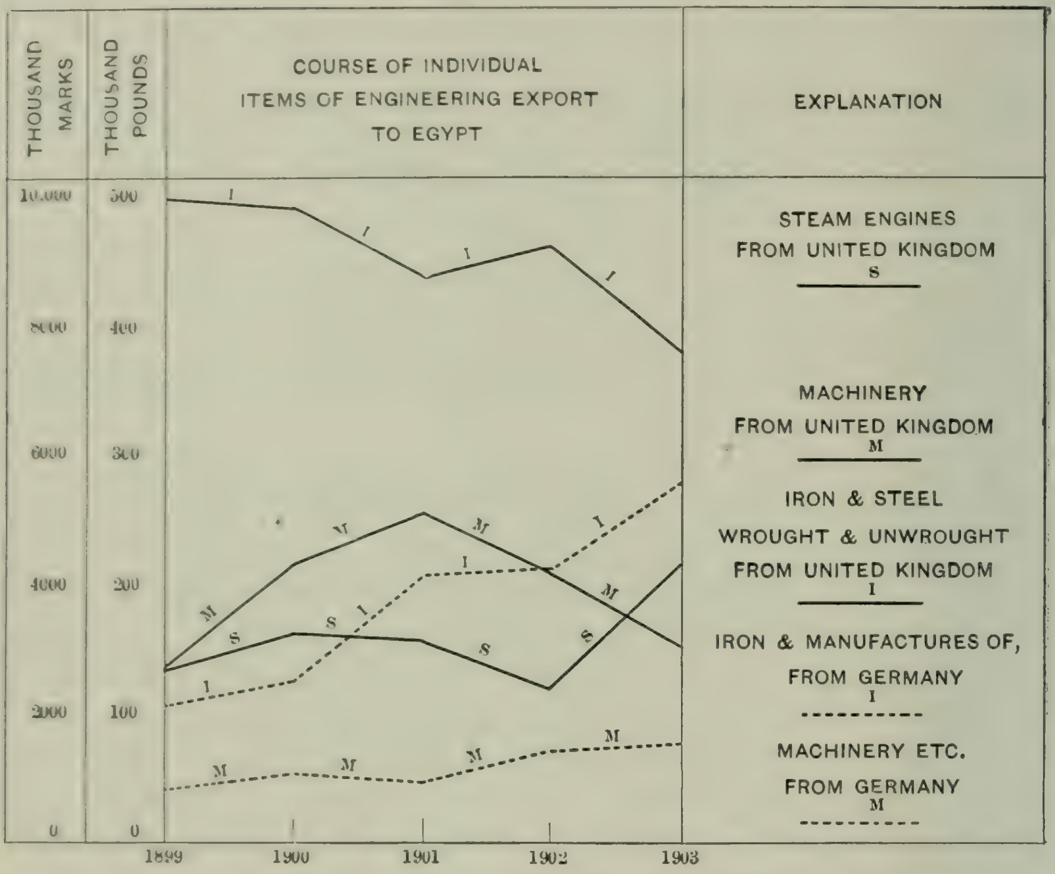


FIG. 2. ITEMIZED CHART OF ENGINEERING EXPORTS TO EGYPT.

the exports from the United Kingdom of iron and steel goods as against an increase in the exports from Germany of iron and iron wares. The British exports of steam engines reached their highest German exports of machinery increasing slightly. Asiatic Turkey is growing in importance as an engineering market, as shewn by the following figures:—

Exports to Asiatic Turkey.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	75	82	85	97	110
Germany	..	77	143	138	179
United States	16	104	75	61	29

While the exports from the United Kingdom have continuously increased, they were surpassed in value by the German exports in 1901 since when they have held second place. The American exports have fallen persistently since 1900.

British East Indies.—Passing eastward around the world, the next large trade zone calling for attention is that comprising Aden, British India, Burmah, Ceylon, and the Straits Settlements. To the British manufacturer it is of considerable importance as is indicated by the following figures of total trade:—

EXPORTS TO ZONE 3.—BRITISH EAST INDIES.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	7,449	7,740	7,209	7,620	7,619
Germany	....	722	1,054	880	1,334
United States	256	301	470	229	130

The chief factor in regard to India's demands for general engineering as well as commodities is undoubtedly that of the presence or absence of a sufficiency of food stuffs for the vast population of 300,000,000 people. A failure of the monsoon results in diminished crops; revenues tend to fall; the peasant who lives through the stress of famine has little wealth available for the purchase of, say, cheap cotton stuffs. There being no crops to be transported, the railways in the affected regions do not need to indent so heavily as usual for

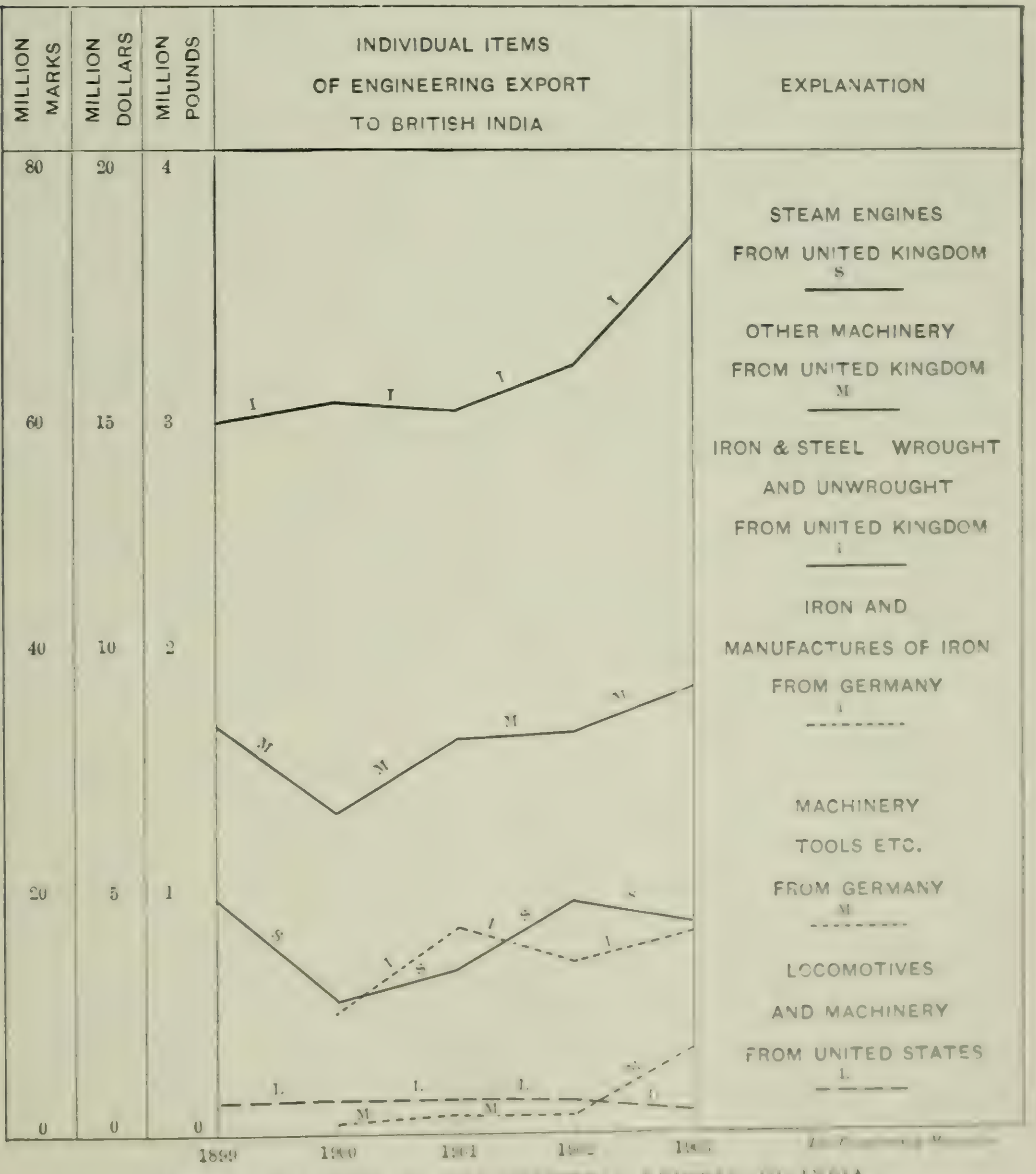


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FIG. 2. CHANGES IN THE PRINCIPAL EXPORTS TO INDIA.

stores, or rails, or rolling stock. The foregoing figures do not show the full effect of the last famine in the British trade with India in engineering commodities. A reference to Diagram No. 2 shews the recovery in regard to three main classes of British and two of German exports after 1900. Although the scale of this itemized diagram is a fairly large one, it does not suffice to show clearly the amounts of the American trade under its chief headings. One curve only is shown of American exports (of locomotives and machinery) and this applies not to British India but to the whole of this zone. From a comparison of diagrams, it will be observed that the British exports of machinery other than steam engines to British India, exceed the combined German and American trade to this zone as a whole. American exports have declined in regard to steel rails, structural iron and steel, locomotives, and general manufactures—indeed, in 1903 the trade in the first three of these items was non-existent. A decrease in the demand for locomotives caused a retrogression in the British exports of steam engines in this year. As regards other materials there were extensive exports of textile machinery, millwork, railroad materials, tinned plates, and so forth.

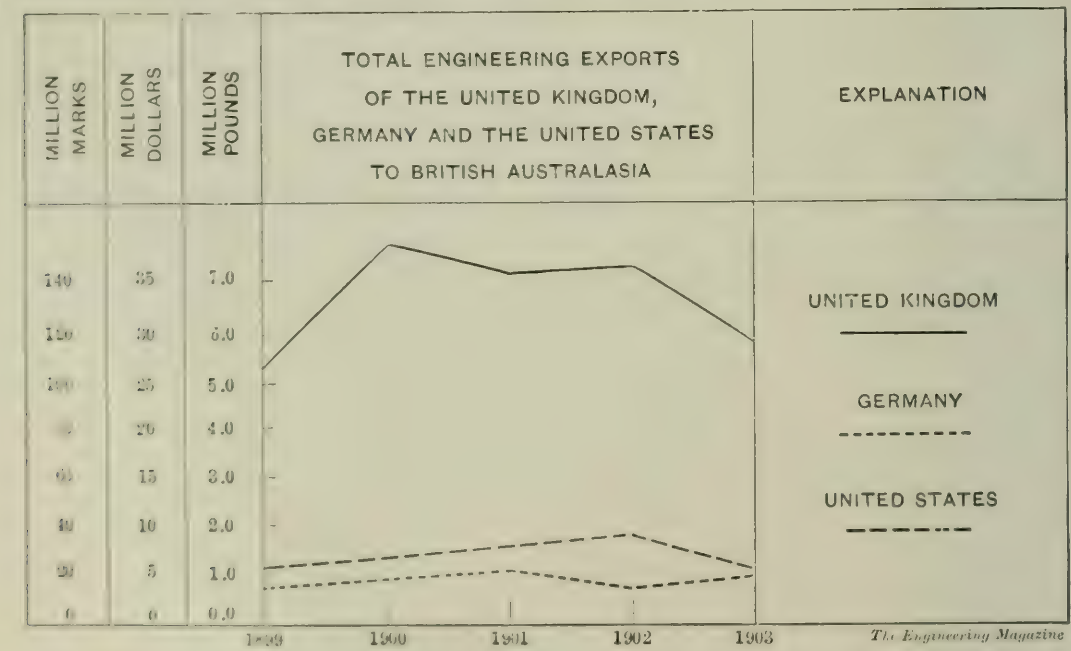

FIG. 3. SUMMARY OF TOTAL EXPORT TRADE TO AUSTRALASIA.

British Australasia.—The continent of Australia which, together with Tasmania, New Zealand, and the Fiji Islands, forms the fourth zone in our discussion, is sufficiently remote from the three chief manufacturing countries to place them practically on a parity as regards freight charges, a slight advantage resting with Great Britain and Germany. In this region, again, British trade largely predominates, as is shown from the following summary of the total trade illustrated in Diagram No. 3.

Exports to Zone 4.—British Australasia.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	5,080	7,701	7,194	7,393	5,971
Germany	767	941	1,113	845	950
United States	1,094	1,477	1,654	1,874	1,220

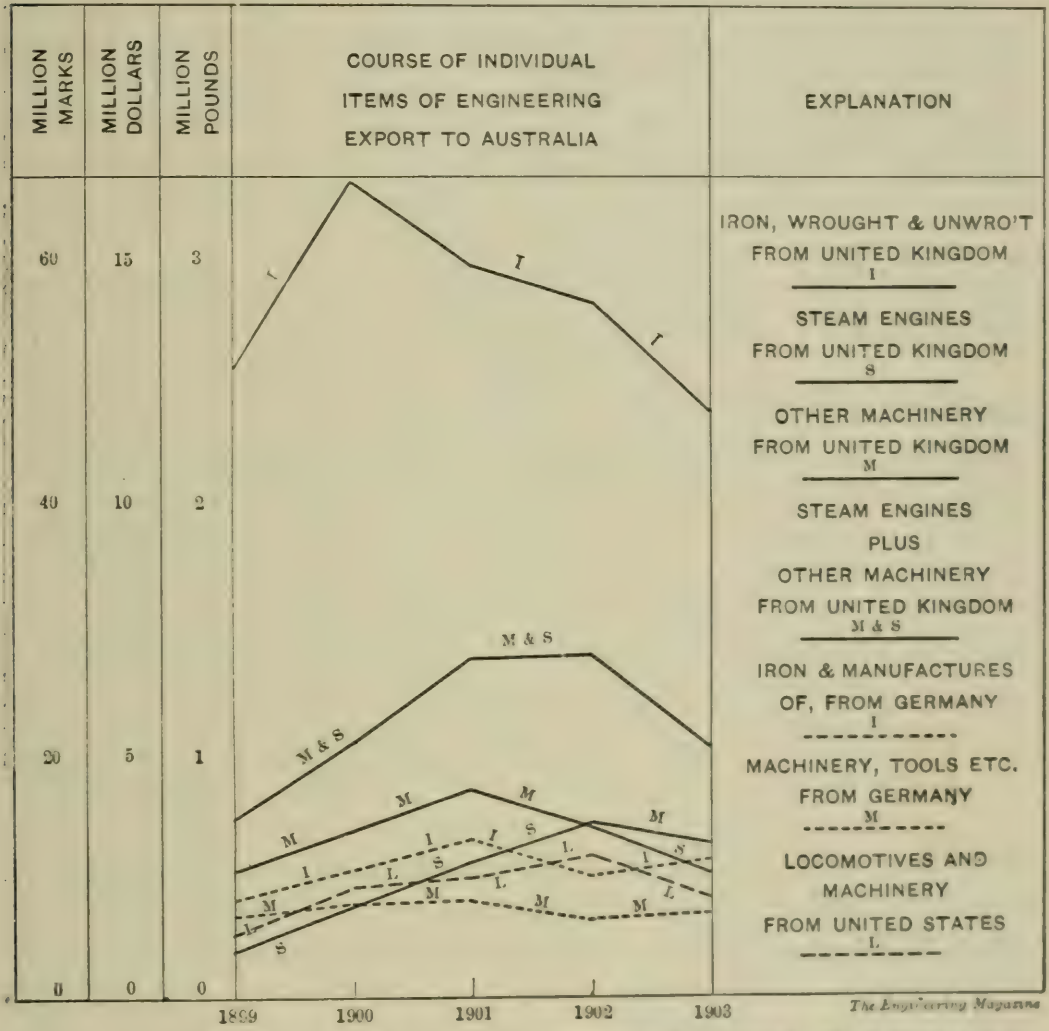

FIG. 4. FLUCTUATIONS IN LEADING ENGINEERING EXPORTS TO AUSTRALIA.

Taking Australia (and Tasmania) separately, the fluctuations in the leading items imported are shown in Diagram No. 4. In this diagram the fall in British exports of wrought and unwrought iron and steel goods is clearly marked. There has also been a German decline of smaller extent. A falling off in the rate of railway extensions is partly responsible. The adverse climate conditions of the severe drought affected the machinery exports of the three countries in 1903. For Germany it will be seen that a single curve marked "M" represent the imports of all kinds of engines and machinery, but that for the United Kingdom marked "M" represents machinery and mill work, but not steam engines for which the curve "S" is drawn. In order to compare the curve of the British engine and machinery trade with the curves representing the trade of Germany and the United States, the curve "M + S" has been drawn, which combines the totals under each heading.

Far East.—As a separate trade zone, the demands of the Far East, which is reckoned as comprising China, Japan, Korea, and the Philippine Islands are exceedingly varied. Government stores go to Hong Kong, and Kiaochow. To these ports also go articles for sale in China. The Philippine Islands have, since the war, become an important market for American goods, needed in the development of a backward country possessing great natural advantages. Above all, Japan has required nearly everything that the engineer can supply—from lathes to armour plates, from dynamos to looms, from ploughs to locomotives or battle-ships. The following are the figures of the total trade:—

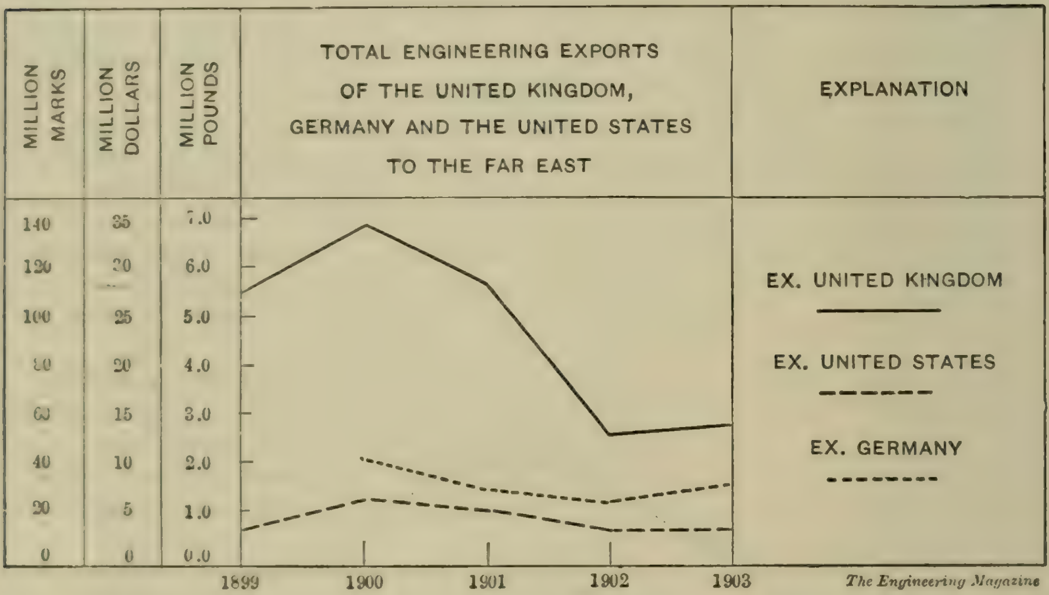

FIG. 5. TREND OF ENGINEERING EXPORTS TO THE FAR EAST.

EXPORTS TO ZONE 5.—FAR EAST.

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	5,592	7,005	5,895	2,789	2,904
Germany	....	2,258	1,558	1,491	1,722
United States	832	1,458	1,225	742	850

Diagram No. 5 represents the above figures. In Diagram No. 6 are shown the exports of the three chief countries to the Philippine Islands; the manner in which the trade of all three countries increased in 1900 being remarkable. British manufacturers will note with in-

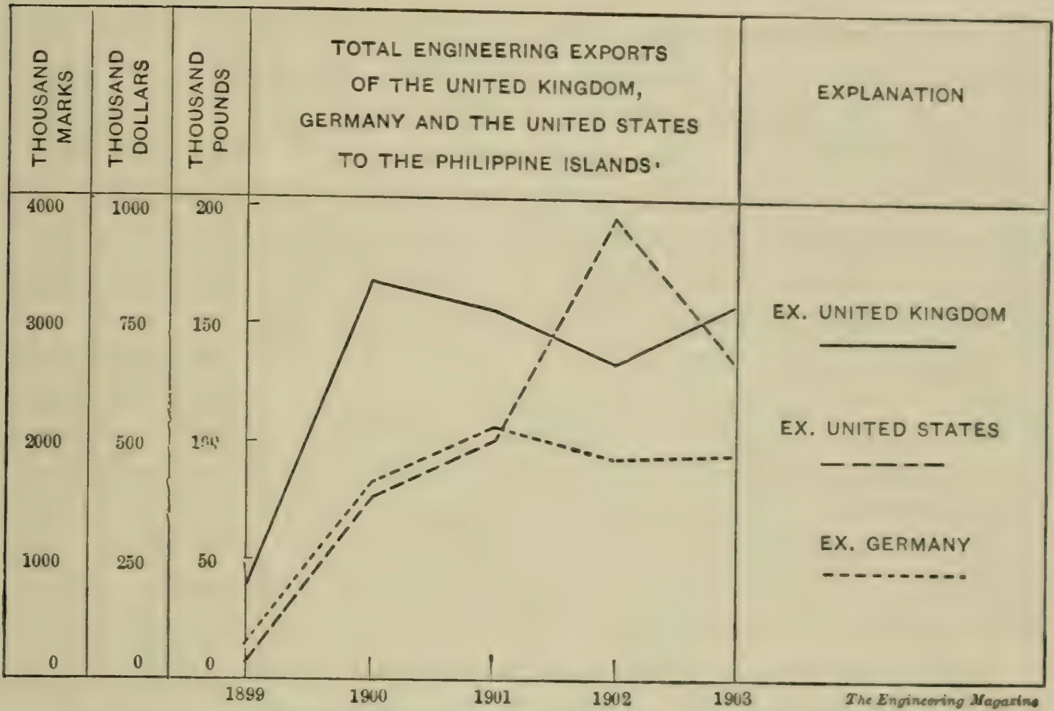

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FIG. 6. EXPORTS OF THE THREE CHIEF COUNTRIES TO THE PHILIPPINES.

terest that in 1903 British exports were again in excess of those of either of the rival countries.

Diagram No. 7 shows an analysis of the engineering purchases of China as a whole. Hong Kong is a larger market and entrepot than is Kaiochow; the German predominance is due to goods sent to

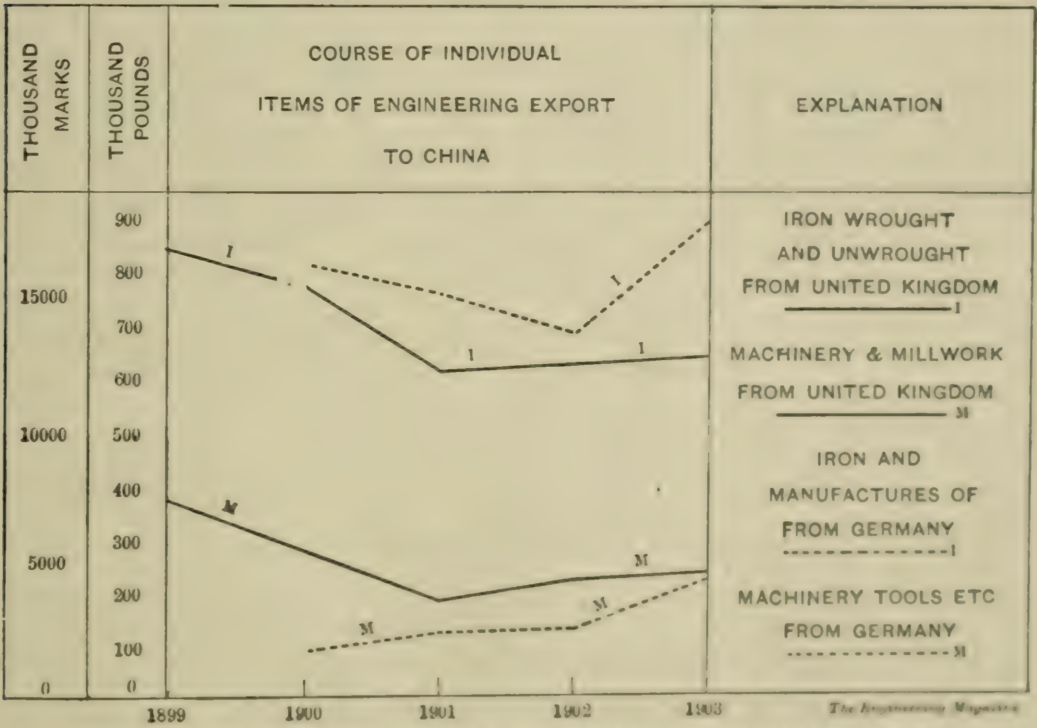

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FIG. 7. AN ANALYSIS OF THE ENGINEERING PURCHASES OF CHINA.

the various treaty ports, rather than to goods sent to Kiaochow. The British position is not satisfactory to British engineering manufacturers, but the American position is still less so.

Japan, which is the chief purchasing country in this group, buys chiefly from the United Kingdom, the second place being held by Germany. Diagram No. 8 shows the export trade of the three countries under various items. In the case of the items of British export, ships and their machinery are not shown by a separate curve, but their value is given below:—

Year	1899.	1900.	1901.	1902.	1903.
Value	£3,413,112	£2,597,994	£3,366,799	£252,080	£55,817

It is due to the fall under this heading that the British total exports (shewn in Fig. 5) to this zone have receded so largely. Purchases of battleships are by no means a constant direction of expenditure, and Japan's purchases have widely fluctuated. Apart from this item the British trade has been fairly well maintained.

South America.—Of the neutral markets of the world, South America is notable in one respect—in that from north to south there

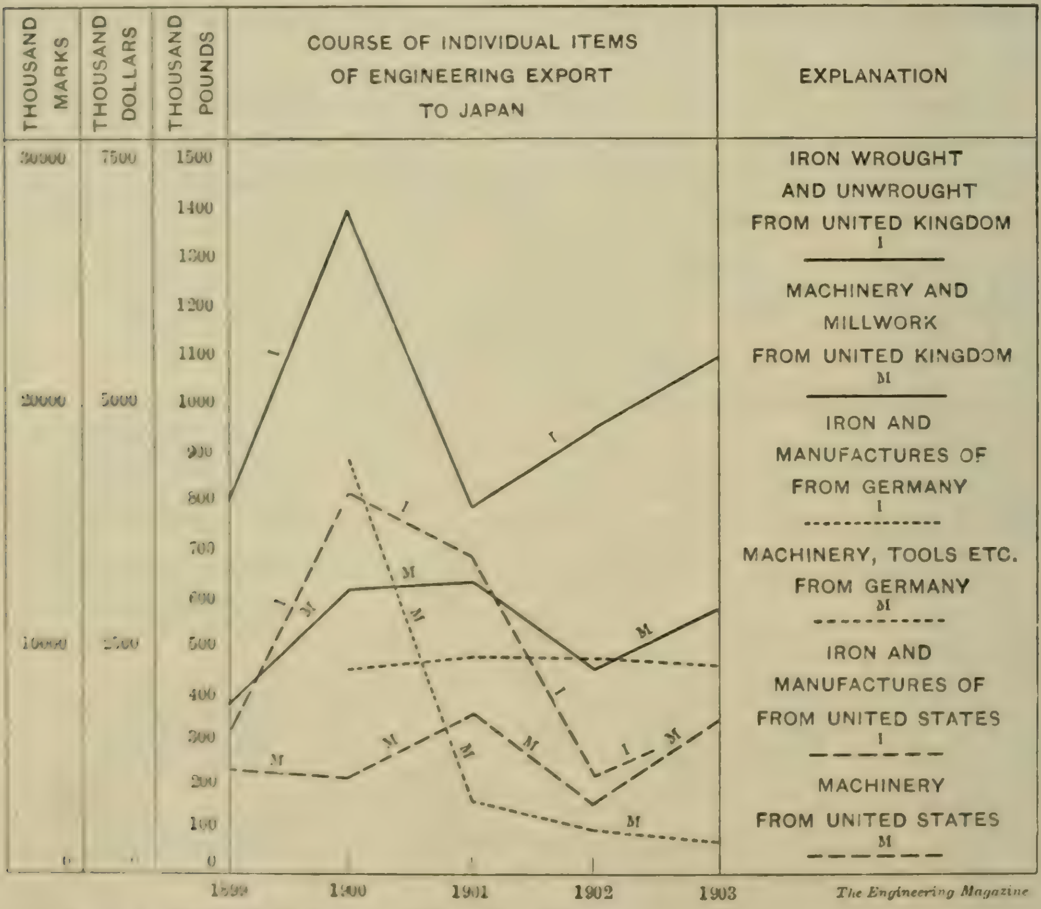

FIG. 8. EXPORT TRADE OF ENGLAND, GERMANY, AND AMERICA TO JAPAN.

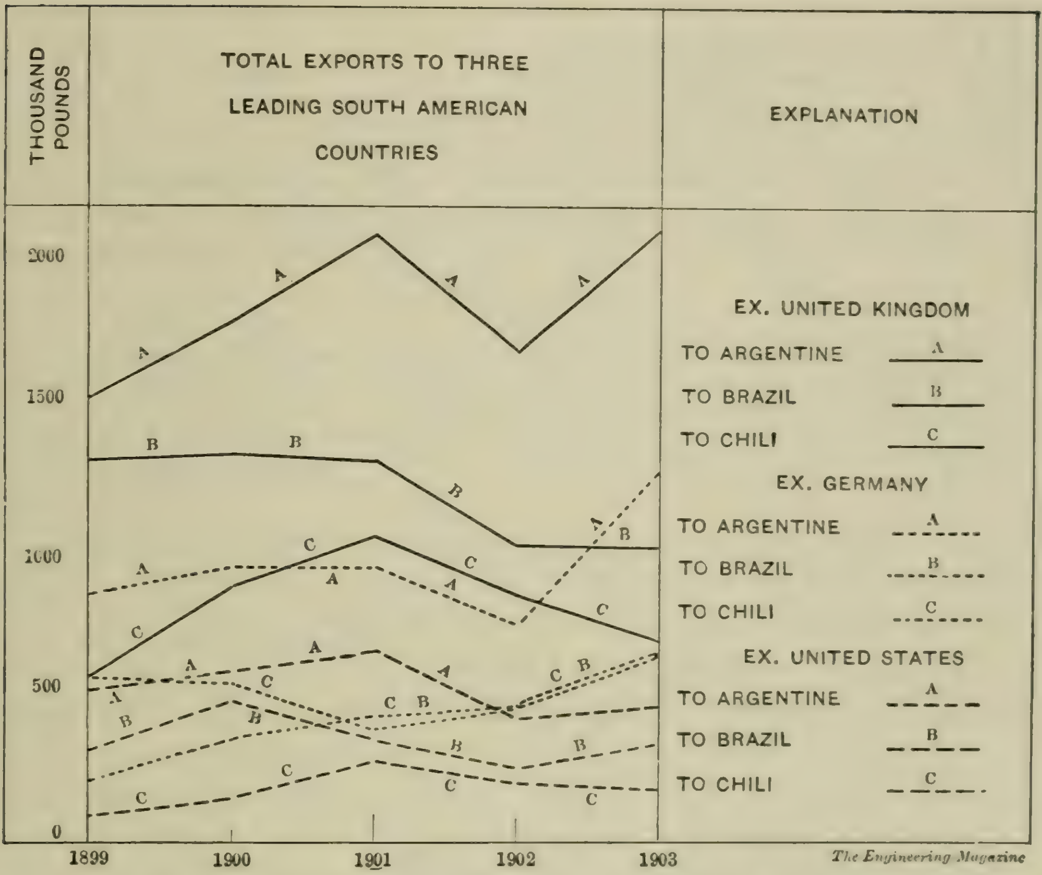

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FIG. 12. EXPORTS TO LEADING SOUTH AMERICAN COUNTRIES.

is but one official language, and that the language not of either of the three chief manufacturing countries, but that of a country formerly a world power. The English, German, and American manufacturers in dealing with a Spanish-speaking people are pretty well on a level linguistically. Not absolutely, however, for the linguistic superiority of the Teuton is largely rendered valueless by reason of the large number of English-speaking engineers who "run" the South American Continent. The following figures show the manner in which the British trade takes the lead, the growth of the German trade, and the stagnant condition of the American trade:—

Year. Ex	1899.	1900.	1901.	1902.	1903.
	In thousands of pounds sterling.				
United Kingdom	3,823	4.539	4.589	4.164	4,396
Germany	1,819	2.234	2,255	2,112	2,978
United States	1,248	1,489	1,761	1.301	1.336

One reason may be put forward as partly explanatory of the inferior position of American trade in this region, and that lies in the fact that the products of the various South American countries are products of food stuffs and raw materials. With these the United States is well equipped, and Great Britain and Germany in competi-

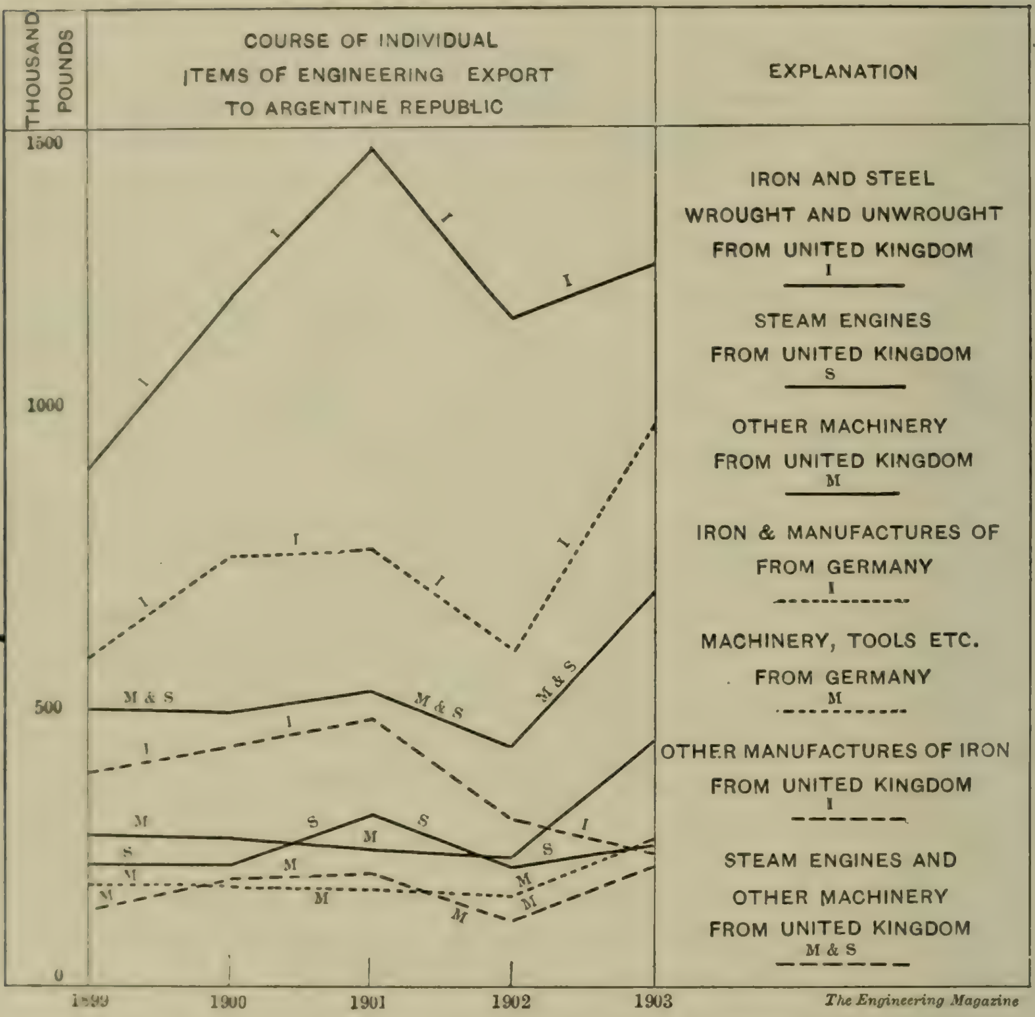

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FIG. 13. ITEMIZED ANALYSIS OF EXPORTS TO THE ARGENTINE REPUBLIC.

tion barter manufactured articles for South American produce. Diagram No. 10 shows the respective exports to the Argentine Republic, Brazil, and Chile, which are the three chief purchasing countries in South America. To each of these countries the United Kingdom sends the greatest proportion, although as regards Chile the German trade now nearly equals the British. The similarity of fluctuation in regard to the trade of each country with the Argentine Republic is rather remarkable. The similarity is more apparent than real, because each year of the American returns ends (as pointed out in the last issue of THE ENGINEERING MAGAZINE) on June 30 instead of December 31. The Argentine Republic being the chief purchaser, it will be of interest to regard its imports as typical of South American demands, and consider the individual items from the three countries. As in the case of India, Egypt, and Japan, the British exports of iron (wrought and unwrought) head the curves. The German exports of iron (and manufacturers thereof) take second place.

THE RELATION OF PURCHASING TO PRODUCTION.

By William D. Ennis.

THE ENGINEERING MAGAZINE has been the source of much of the existent literature dealing with the organized study and management of two of the great elements in the economy of manufacturing—labor, and general expense. We believe it will be of interest to supplement these with a further study of the application of scientific business methods not only to the internal handling, but also to the supply, of the third prime factor in manufacturing—materials.—THE EDITORS.

ASSUMING that the works superintendent is responsible for the consumption of materials per unit of output, while the business manager is accountable for the cost thereof, there appears a necessity for a third element in industrial organization, having jurisdiction over the prices paid for materials. This is the function, as usually understood, of the buyer. He is technically differentiated from both superintendent and manager, bearing no formal responsibility regarding the consumption of materials, either absolute or in proportion to production; nor, usually, regarding the costs per unit of production, so long as the prices paid are low. This strict limitation of the accountability of the purchasing department is, and should be, never adhered to. Properly considered, buying has other relations intimately associating it with considerations of production-intensity and profit, the nature of these relations, and their utility, depending upon the kind of industry and its mode of organization.

For the present purpose, all productive industries may be comprehended under four general classes, in which the purchasing departments naturally develop in different directions, and with almost wholly different bearings on operation.

I.—The Trading Industry. This class comprises such kinds of manufacturing as are usually quite intimately associated with some phase of agriculture or mining—which utilize one principal raw material, the direct product of the earth, subjected to one simple general process; in which the amount of labor involved may be large or small, without affecting the general principle underlying such industries—that of a simple treatment of a single material. Transportation is often a large factor. Typical establishments in this class are linseed and cottonseed oil mills, ground wood-pulp mills, and flour mills. The purchasing of the raw material in such industries is the vital feature, and as such is almost always taken charge of directly by the chief executive. Such other buying as is done, usually limited to a few items like packages, fuel, etc., is repetitional, and does not require exceptional skill; neither has it such fundamental relations with manufacturing costs as exist in other industries; nor does it involve the amount of detailed attention necessary in the purchasing department of a more complex manufacturing business.

2.—The Factory. Using the word in a narrowed sense, this term applies to that kind of business in which labor, directly employed, is the vital item—such as a textile mill, or the ordinary machine shop on small work. In these, purchasing efficiency is almost wholly subservient to conditions of productive intensity, the main point in buying being to err, if at all, on the side of extravagance, rather than take any chance of interrupting or complicating the routine of operation. In this, as in the preceding class of industries, the buying of any large elementary raw material is committed to the direct care of the management; other buying is apt to be an insignificant item, unless in connection with the repairs and maintenance of the plant, in which direction buying is of so highly specialized a character as not to permit of much comparative analysis.

3.—The Service Corporation. This includes such enterprises as power and water-supply plants and gas works. These, partaking in some respects of the distinguishing features of other classes, have the characteristic of a usually large construction and maintenance department, often (perhaps usually) superintended separately from the operation of plant. This superintendence itself consists largely in buying, under contract or otherwise, the buying being specialized to the highest degree and demanding usually not only commercial but technical experience as well.

4.—The Manufacturing Business. In the arbitrarily limited sense in which this description is here applied, it refers to that large class of plants in which the raw materials are many, the items of cost several in number and of commensurable magnitude, the prices of materials having a wide range, with proportionate effect on cost of production, and the labor item not an overwhelming one. Such a description comprises establishments like paper mills, some chemical industries, and the usual order of engineering works. In these, efficient buying is of prime importance, often fully as important as efficient superintendence of plant, in its effect on cost of production. Its relations with superintendence and management are close and constant, and its organization should be effected with a view to making such relations most mutually profitable.

It goes without saying that the lines separating the above four classes of industrial plants are too sharply drawn, and that the distinctions made are modified in many ways, involving corresponding modifications in the organization and conduct of the department of buying. The object of this classification being, however, to limit the discussion primarily to the scope of purchasing in the fourth class, or more purely manufacuring business, its utility will be recognized.

In the organization of a purchasing department, one complication often exists—that of a warehouse or stores department, to which all supplies are charged, and which in turn delivers them to the appropriate departments, charging to the proper account at the time of delivery. Justification for a warehouse department may be found under any of the following conditions:—

a. Where the same materials are used by more than one department.

b. Where a large or valuable stock of materials is left on hand, the invoices do not represent the rate of consumption, and accurate monthly inventory by departments is impracticable.

c. Where the cost of repairs is a large item and requires analysis; in which case, the warehouse department should deliver goods to the repair department only on requistion showing to what department and use the material is to be applied, thus recording the repair expense by departments.

In cases where the organization comprises such a warehouse department, copies of all purchasing requisitions or orders should be filed at the warehouse, these not necessarily being endorsed with prices. This department is then responsible for the receipt of materials in good order, their weight, quantity, and in a general way, their quality, thus relieving both purchasing and operating departments of some of the duties of inspection. The warehouse department can approve the invoice items "goods received," "quantity O. K.," and in some cases, "quality O. K." (Form 1.) The plant manager can of course determine in each case whether the warehouse department's approval of quality should be final. If it is preferred that the invoices should not pass through the warehouse, then that department should report daily, or oftener, on the receipt of goods, stating shipper, quantity and apparent quality (per brand or label, or as to condition). These reports constitute the basis for the purchasing department's approval of invoices; in addition to which it should secure the approval of the operating department as to quality, and may itself approve prices and discounts and pass bills for payment.

In order to avoid, or at least to fix responsibility for, delays, the items "goods received," "quantity O. K.," "quality O. K.," and "date approved," should always be endorsed with the dates of receipt, inspection, and approval, as well as with the initials of the approver. Form I shows the plan of endorsement recommended for invoices.

Pur. Order No. ________	**Req. No.** ________
Goods Rec'd ________	**Account** ________
Quantity O.K. ________	**Quality O.K.** ________
Price O.K. ________	**Date Approved** ________

Approved for Payment
________ **Buyer**
________ **Auditor**
________ **Business Manager**

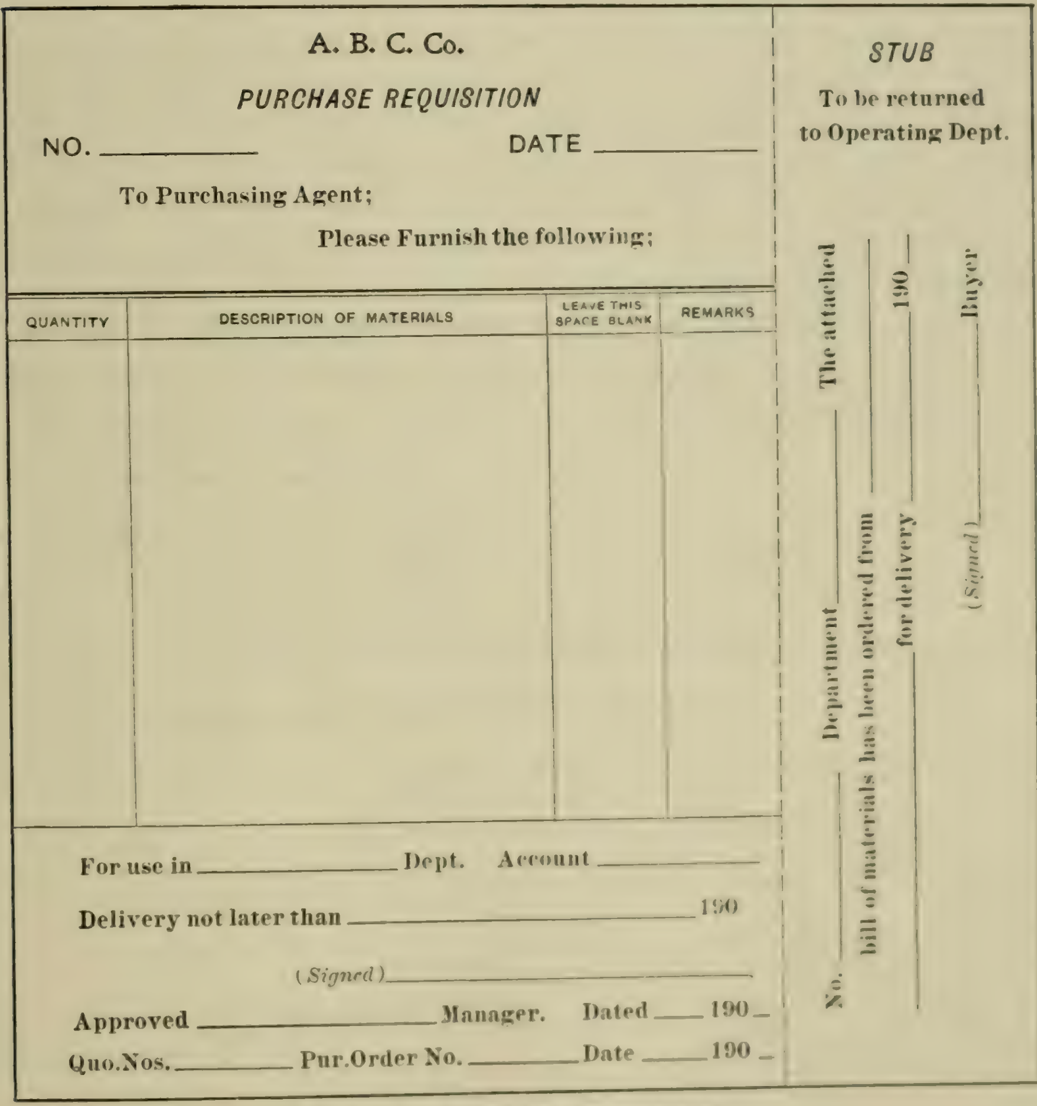
FORM I. RUBBER STAMP FOR INVOICE APPROVAL.

The "Requisition Number" refers, of course, to the requisition from the operative department, often elicited by suggestion. These requisitions are made out in duplicate, the copy being retained. In order to avoid delay in the payment of bills and consequent loss of discount, the above form should be stamped on every invoice as soon as received, which then becomes "live" and calls for attention until fully endorsed and passed. Sometimes the additional item, showing the date of receipt of the invoice, is desirable. This should always be embodied in the stamp when a time stamp is not used for all mail received. Other items may be desirable for convenience in accounting. In cases where materials arrive before the invoice, the daily warehouse reports consititute "live" matter, suggesting a prompt call on the shipper for the bill. The four approval signatures provided for on the above form are not in all cases required; but in general, all charges should have the approval of operating, purchasing, and auditing departments—where possible, the executive also.

The following page shows the recommended form for requisition on the purchasing department, which should be invariably adhered to, as showing the origin of every expenditure for supplies.

The number on this requisition should correspond with that on the stub, both being printed in. Where requisitions originate from several branches or departments, their numbers should have distinguishing letters prefixed. The blank space in the body of the requisition is for temporary memoranda regarding prices, by the buyer. The space headed "Remarks" can be used by the formulator of the requisition to embody any recommendations or advice as to quality, source of supply, or prices. The item "for use at" shows the name of the branch or department. The various datings and other particulars given (with the usual time stamp showing the hours of receipt) specify the dates of requisition, of approval, of action by the buyer, and of purchase. The quotation numbers refer to the quotation file, hereafter to be referred to. The stub forms an acknowledgment showing the operating departments that the requisition has been received and attended to, and giving all necessary information as to probable delivery. Many of these entries may be by rubber stamp.

Even after a purchasing order has been issued and the requisition stub returned to the operating department, the requisition is still a



A. B. C. Co.

PURCHASE REQUISITION

NO. ________ DATE ________

To Purchasing Agent;

Please Furnish the following;

QUANTITY	DESCRIPTION OF MATERIALS	LEAVE THIS SPACE BLANK	REMARKS

For use in ________ **Dept. Account** ________

Delivery not later than ________ 190

(*Signed*) ________

Approved ________ **Manager. Dated** ________ 190 _

Quo.Nos. ________ **Pur.Order No.** ________ **Date** ________ 190 _

STUB

To be returned to Operating Dept.

The attached ________ **Department** ________ **No.** ________

bill of materials has been ordered from ________

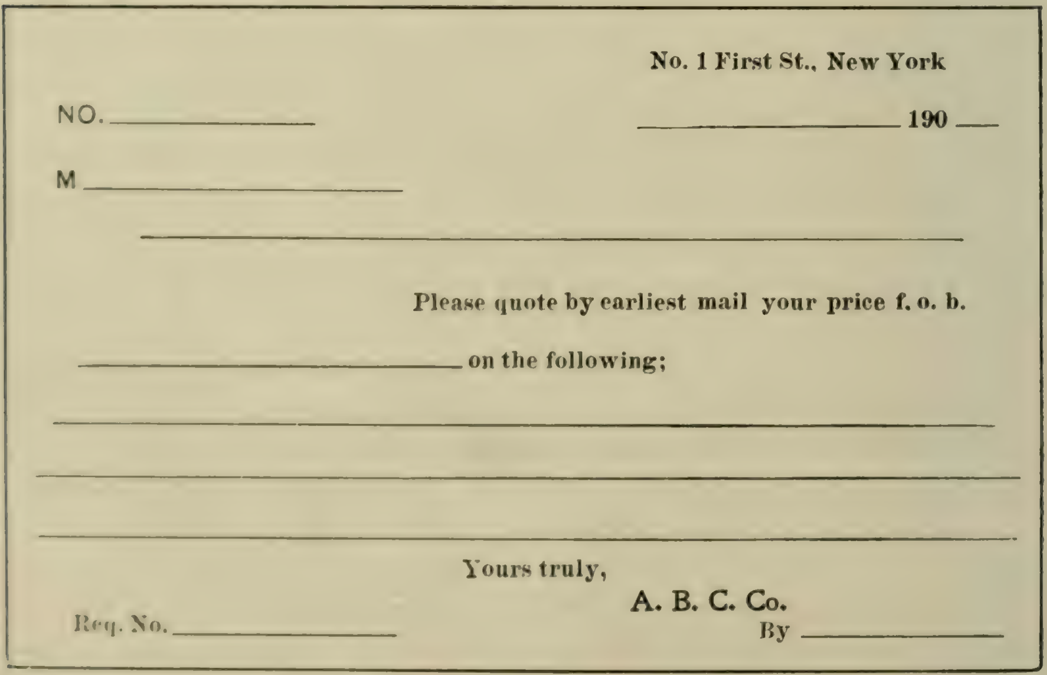
for delivery ________ **190** ________

(*Signed*) ________ **Buyer**

FORM 2. PURCHASE REQUISITION.

"live" document, and remains so until the plant (or warehouse, if any,) reports the delivery of the goods. It may then be filed, the delivery report or invoice taking its place. It is at this point that the critical point of effective buying appears. The efficient buyer must deliver materials on time. It is for this reason that all requisitions must be held as "live documents," until there is proof of shipment and delivery. This point will be referred to later.

The receipt of a purchase requisition properly endorsed is the buyer's warrant for action. To save time, or for other reasons, it may frequently be necessary to get prices before the final approval of the requisition; perhaps in some cases the completed purchasing order will be attached to the requisition for joint approval. The first step after receiving the requisition is to decide whether or not a price-quotation should be secured before ordering. Standard goods, like pipe and fittings, bar iron in small lots, cement, etc., may vary in price so slowly that it is not necessary in all cases to call for prices. Where quotations are desired, time may be saved by using the following form, on which the buyer enters only the names of the parties from whom quotations are to be secured, and the number of the requisition. He will have previously made note on the requisition itself of any details or modifications in the specification of the material, so that a subordinate may copy the further particulars necessary into the quotation-request form. When quotations are secured by telephone, all the prices may be entered on a single card.



No. 1 First St., New York

NO. ______ ______ **190** ___

M ______

______

Please quote by earliest mail your price f. o. b.

______ **on the following;**

______

______

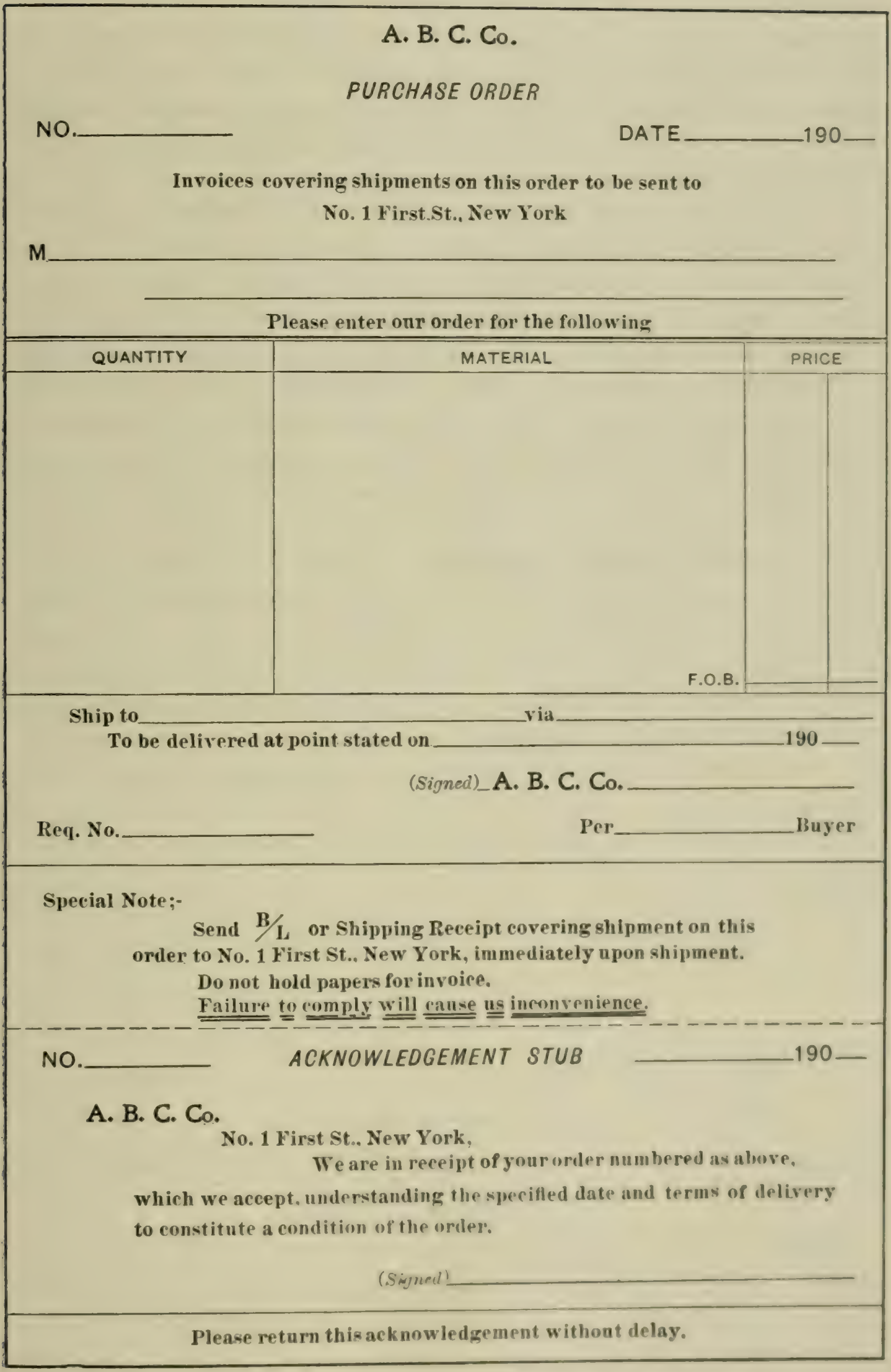
______

Yours truly,

A. B. C. Co.

Req. No. ______ By ______

FORM 3. REQUEST FOR QUOTATIONS.



A. B. C. Co.

PURCHASE ORDER

NO.________ DATE________190__

Invoices covering shipments on this order to be sent to
No. 1 First St., New York

M____

____

Please enter our order for the following

QUANTITY	MATERIAL	PRICE	
	F.O.B.		

Ship to________________via________________
To be delivered at point stated on________________190__

*(Signed)*_A. B. C. Co.________________

Req. No.________________ Per________________Buyer

Special Note;-
Send B/L or Shipping Receipt covering shipment on this order to No. 1 First St., New York, immediately upon shipment.
Do not hold papers for invoice.
Failure to comply will cause us inconvenience.

NO.________ *ACKNOWLEDGEMENT STUB* ________190__

A. B. C. Co.
No. 1 First St., New York,

We are in receipt of your order numbered as above, which we accept, understanding the specified date and terms of delivery to constitute a condition of the order.

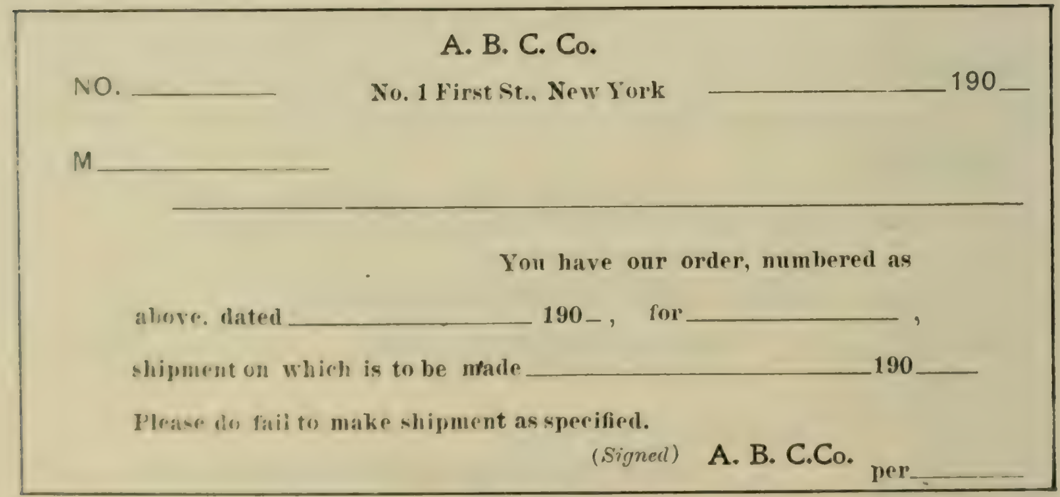
*(Signed)*________________

Please return this acknowledgement without delay.

FORM 4. PURCHASING ORDER AND STUB.

This blank is endorsed in duplicate, the copy being on a stiff card, suitable for filing, on the blank margin of which the price quoted is afterward entered. These quotation cards are filed according to the consecutive printed numbers in the upper left-hand corner, and an index register is posted daily. The last quotation number indexed shows the most recent quotation for that particular material. Red tabs may be employed on the cards, and check marks on the quotation index, to designate low prices. The entry of quotation numbers on the purchase requisition (Form 2) shows the number of quotations obtained. As quotations are received, they should be temporarily attached to the requisition, not being filed until the purchasing order has been issued. The latter may be as shown on page 525.

Having now placed the order, a book copy being retained, the next duty of the buyer is to see that the acknowledgment stub arrives by the earliest possible mail. This he attaches to the purchase requisition. It is then his concern to see that the goods arrive at their destination at the proper time. As already stated, he holds on file all original purchase requisitions. These are arranged, not in numerical sequence, but in the order of the specified date of shipment; and it should be the rule to examine and act on these daily. When the specified day of shipment approaches, the following printed note or post-card is despatched. The number, of course, corresponds with the purchasing-order number.



A. B. C. Co.

NO. ________ No. 1 First St., New York ____________190__

M____________

____

You have our order, numbered as

above, dated ______________ 190_, for ____________,

shipment on which is to be made ____________________190____

Please do fail to make shipment as specified.

(*Signed*) A. B. C.Co. per________

FORM 5. SHIPPERS' REMINDER.

Possibly two or even more of these reminders may be required before a response is elicited; in which case each succeeding one should have some expression of urgency stamped across its face. It is not the business of the buyer to determine *how* urgently goods are needed; he should see that all goods are delivered on time. If there is incompetence in the formulating of requisitions, delay in filling them is not the remedy.

Should the specified day of shipment pass without receiving papers showing that the goods have been shipped, special and prompt action should be taken, the steps being usually in the following order:—

a. Ascertain when shipment can be made.

b. Ascertain how much delay in arrival of the goods can be tolerated.

c. Cancel the order if necessary, and buy elsewhere.

At this stage (and, as a general rule, at this stage only) free use should be made of the telegraph and telephone. The function of the buyer should be active and not passive, in this as in the still more important phase of testing and inspecting materials purchased, and the somewhat elaborate system above described is certainly far better in every way than a haphazard method of taking things for granted, and waiting for a protest from the plant before being concerned with any thought as to the possible non-arrival of goods.

Any extension of time for the delivery of materials or a purchase requisition acts as a stay on the "life" of the requisition. Its vitality does not cease until the arrival of the shipping papers or warehouse receipt, either of which may take its place until the arrival of the invoice, which becomes the final document in the transaction, and is itself "dead" to the purchasing department so soon as it is fully endorsed and passed for payment.

An inexpensive and probably profitable courtesy in connection with this system is the use of one more typewritten or printed form thanking correspondents for quotations received in reply to Form 3, and stating if possible the reason why the purchase is not made from such correspondent. It will probably be found most effective to have such cards mailed quite promptly after the receipt of quotations, and two or three days before the order is placed.

A separate requisition from the operating department should be insisted on for each item or class of items. Where orders are sometimes placed by telephone, a stamp should be used showing the confirming order to be such and cautioning against repetition. A special blank form on which the operating departments may call on the purchasing department for prices may be useful, where the cost of some projected improvement or change in operation must be calculated.

Sometimes a considerable amount of correspondence is necessary before a quotation is obtained or an order placed. In this case (as in all other slips of the system) there should be practised rigorous "follow-up" methods; the purchase requisitions (until the order is placed) being filed in order of the dates when next action is due, or a calendar register kept, listing for each day the number of purchase requisitions calling for action.

Among indispensable aids to efficient buying, the complete quotation file, previously referred to, should have first attention. Supplementary to this, there should be intelligently designed records showing the variations in prices of the principal supplies purchased, accompanied by thorough analyses showing the reasons for the variations. Any opportunity for comparison of prices with those paid for the same materials by others should be taken advantage of, and the facts recorded. To be most fully familiar with the markets, the buyer should be supplied not only with his own trade papers, catalogues, and other publications, but also with the trade papers covering the markets he most often enters. These can usually be had gratis. Thus, if he is a large buyer of barrels, he should have the cooperage papers; if of building materials, the corresponding trade publications; etc. A card index may be maintained (sometimes combined with the quotation file, sometimes separately) showing the available sources of supply of the usual materials purchased. This can be supplemented by cards or an indexed scrap-book referring to information of all kinds obtained regarding prices and market conditions. At the earliest date which the development of the system will permit, a thorough analysis of expenditure should be made, showing the amount purchased of each kind and class of materials; the best season for buying each; the usual amount of stock on hand, and the permissible size of order. This information may often be of value in eliciting a requisition by suggestion when the time is opportune. In this as in other directions the usefulness of the buyer should assume an active form. Where the organization is large, so that the personal attention of the buyer cannot be given to the details of all purchases, the materials should be grouped in general classes and each class handled by one subordinate. Special knowledge is just as essential in purchasing as in manufacturing. Opportunities for visiting plants and learning factory conditions and methods as applied to the principal raw materials purchased, should be constantly sought. Familiarity with the uses of materials in the business should be obtained.

The prices at which goods are secured do not adequately represent the work of the buyer. The effect on production and cost of production must be more fully considered. With equal operative efficiency, effective buying is fully shown by the cost of materials per unit of output. A low price coupled with high consumption per unit of production calls for investigation. It is too often the case that the buyer seeks the goods of lowest price, the plant operator being compelled to accept whatever is furnished. This lack of co-operation should be eliminated. The first essential is to have frequent, perhaps periodical, reports on the quality and appropriateness of all goods supplied, as determined by observation under service. Next is a system of promptly reporting on defects, showing the reasons for such defects and furnishing samples of defective goods. A more satisfactory and scientific system involves also the purchasing of materials on carefully drawn specifications, compliance with which is to be determined by laboratory tests. All usual materials may be bought in this way—paints, oils, brick, cement, iron, building materials generally, pipe, fittings, and pipe covering can be judged as to quality and suitability often with far more accuracy and promptness by laboratory tests than by actual service. In the mill, conditions are variable and the personal equation has too large an effect. In comparing different kinds of belting, for instance, it is almost impossible to formulate fair conditions for a service test, or even such as will constitute a safe guide in buying. Moreover, a service test requires considerable time, often several months, during which a possible saving may be delayed; and a delayed saving is always a loss. A bureau of tests, working in close co-operation with purchasing and operating departments, and held responsible in cases of complaint as to quality of goods under service conditions, this bureau furnishing specifications to the buyer and reporting as to compliance therewith, should be an adjunct to the purchasing work in most large industries. Where, after buying has been conducted along these lines, there is any complaint from the operating department, the testing department should investigate. Varying service conditions may have an influence on durability and consumption which must be recognized in the drawing up of specifications and schemes for laboratory tests; but all complaints should receive searching investigation, and the "why" be made known, prior to such modification. Sometimes it is an improper operating condition which needs correction, rather than a defect in materials.

In a purchasing department, whether large or small, simply or complexly organized, many documents must necessarily pass through several hands; and methods of avoiding loss, locating papers, etc., in vogue in other industrial systems, such as taking receipts by documentary numbers from each individual or department receiving them, should be adapted to the particular requirements.

In certain industries of exceptional magnitude, natural modifications in the methods and organization of the buying department occur; notably, for instance, in purchasing for railway companies. In the recent "integrated" mode of organization of many industries, involving the combination under one direction of a number of geographically separated plants, it has seemed wise to form a new basis for buying, consisting in the establishment of a central purchasing department, which takes direct charge of the buying of the larger and repetitional items, supervising at the same time the local purchasing of smaller items at the various plants. In most respects such organization does not differ in proper object and methods from the buying department of an isolated plant. It is usually the case that purchases made by the branches will be paid for at the branches, the vouchers afterward being sent periodically (best weekly, rather than monthly) to the general office, where they should pass through the hands of the purchasing department for approval. More direct control is secured by having the purchasing orders issued by the branches always made in triplicate, so that in addition to the copy retained at the branch office, another copy, completely endorsed as to price, may go immediately to the general purchasing department. If action should be necessary, it may then be taken at this stage, when it is often not too late to discuss or even to cancel an order. When vouchers come in, they should be checked against these purchase-order copies before going to the auditing department.

Where all bills are paid from the general office, the invoices are checked against the branch-office purchasing-order copies and warehouse receipts, and usually need not be sent to the branch for approval. This is the best form of control, but is seldom fully practicable on account of the delay involved in payment where the plants are widely separated from the general office. Where purchases have been made by the central office, the branch manager's approval of warehouse reports, forwarded by him to the buying department, enables that department to complete the endorsements on the invoice and pass it for payment. When the purchase requisition, Form 2, is used in local purchasing, some of the items may be eliminated without loss. In using Form 4 for branch-office purchases, the address should be that of the branch, unless all invoices are handled by the central office.

One of the principal advantages in purchasing-department organization, in an "integrated" industry, is the opportunity given for the comparison of prices paid on purchases of the same material by different branches. These should be constantly set side by side and variations justified or corrected.

PROGRESS IN VALVES FOR AIR AND GAS COMPRESSORS.

By Leicester Allen.

IN reply to the query "why do not the builders of steam-driven blowing engines, instead of using air cylinders of seven-feet diameter and five-feet stroke, use cylinders of less diameter, and for a speed of, say, forty-two revolutions per minute substitute a speed of one hundred revolutions per minute?" I received from one of the most accomplished and competent engineers in the United States the following statement, which I give verbatim:

"It has been found almost impossible to get an air valve-gear which would work satisfactorily at speeds much above fifty revolutions per minute on low-pressure work where the air cylinders are very large, and where the valve area, particularly that of the inlet, must be a very large percentage of the piston area in order to prevent a suction loss in filling the cylinder."

Again, in conversation with another able engineer, the superintendent of a well-known compressor works, regarding the possibility of improving the piston packing of air compressors, I was met by the statement that, while pistons could doubtless be improved, the need for improvement in valves was more pronounced, and that, as yet, for all kinds and sizes of compressors, and for all uses, no all-around satisfactory valve has been produced.

The poppet valve is the type most used during a period of thirty years. At one time it was flat-seated. Then the conical seat prevailed. Now some manufacturers are going back to the flat seat. For some purposes a single slide valve for suction and discharge in a double-acting compressor has answered well, even with a maximum unbalanced pressure of 150 pounds per square inch between suction and discharge. A slide valve for the suction with a poppet valve for discharge is also used for some compressors. Mechanically operated inlet valves of the Corliss type for the suction, and poppet valves for discharge, are now quite extensively used. These changes have followed each other in the quest for the ideal compressor valve which, when it arrives, will meet the requirements for all compressors, of whatever size they may be or whatever may be their application in the industrial arts; and, as change always argues dissatisfaction, it seems that I am backed by authority of first-rate engineers, as well as the facts in the history of air compression, when I assert that a perfectly satisfactory type of valve for air compressors does not exist.

The term, "air compressor" applies in its broadest sense as perfectly to what is more generally termed a vacuum pump as it does to a compound compressor which, inducting air at a pressure of one atmosphere, effects a pressure of twenty-eight atmospheres; in fact, the ratio of compression in a pump producing a vacuum as low as one inch of mercury is about 30, or as great as in compressing air at 62° F. from one to 29.92 atmospheres. But while for a small laboratory vacuum pump a valve of oiled silk will answer well for the suction, the poppet valve of the large blowing engine with suction pressure of one atmosphere requires a ponderous casting. If two suction valves are used for these large air cylinders, even with a mean velocity of flow through the valve openings of 8,000 feet per minute, it can be readily computed that the combined suction area for the air cylinder of a blowing engine 7 feet in diameter and 5 feet stroke must be 3.88 square feet; the diameter of each valve, if opened to full area, would be 18⅞ inches, nearly. Its lift to give full area would be a little more than 4¾ inches. It is easily conceived that such a valve, cast integrally with guides and strengthening ribs, must have a weight which, for practical reasons, precludes its actuation by a spring, and seating with a blow; hence they are actuated mechanically by rock-levers. But, at the best, quick seating of such a valve is impracticable and the speed of the engine is thus limited. It is true, however, that in blowing engines where gas instead of steam is used, a speed of 90 revolutions has been reached by the use of mechanically actuated valves. Few mechanical engineers, not directly engaged in the manufacture of air compressors, have considered the wide range of conditions here outlined as existing between the small vacuum pump and the ponderous blowing engine; and, in view of all the requirements, it may be doubted whether a valve meeting them all satisfactorily will ever be forthcoming.

But though vacuum pumps are, strictly speaking, compressors in the most general sense of the word, they are not commonly so called; and they have a peculiarity in their action which practically puts them—and all compressors which, after compressing to a stated pressure, cease working—in a class by themselves. This peculiarity is that their ratio of compression, when the space to be exhausted contains air at atmospheric pressure, is zero at beginning, and constantly increases to the end of the operation. It is true that compressors taking air at atmospheric pressure and forcing it into a receiver until the latter is filled with air at a prescribed pressure, start with a zero compression ratio which increases till the stated pressure in the receiver is attained; but at this period the compressed air is taken from the receiver as fast as it is forced in, for driving air motors or for other useful purposes. If this be done uniformly, the ratio of compression thereafter remains constant. If the air be drawn from the receiver in irregular quantity, there will be greater or less approach to uniformity in the ratio of compression. It will increase or decrease according to the demand for the compressed air, but will not constantly increase as is the case with the vacuum pump. It is, doubtless, this variation in pressure ratio, more than any other cause, which has influenced the use of poppet valves for the discharge of air compressors, aside from their automatic action which requires no special mechanism to control their movement except a spring to insure their prompt closing. It is, doubtless, also the fact that, because this variation of pressure ratio does not exist in connection with the filling of the compressor, or the suction, the use of positively actuated suction valves, in place of poppet valves, has been evolved in modern practice.

In cold-air refrigerating machines which use compressed air, delivered by a compressor, in an air engine wherein the air is expanded for the production of cold and the work of the expansion assists a steam engine to drive the machine, as soon as the machine arrives at the point of normal working, the pressure ratio becomes constant. The ordinary slide valve with a cut-off slide on the back works satisfactorily on these machines, and has been in use for years without creating a desire for anything better. There is no question that such a valve can be practically applied to any compressor which works under a constant pressure ratio. Of course, with this kind of valve the suction is effected through what is the exhaust port, and the compressed air is discharged through what are the induction ports in a steam engine, the course of the air during its passage being exactly the reverse of that of steam. The slide on the back of the main valve uncovers the valve port at the point of the piston stroke whereat the pressure of discharge is reached, instead of covering the valve ports at the point of cut-off, as in the steam engine. These valves work noiselessly, and as only one is required for a double-acting compressor, while, at the least, four poppet valves are required, and as they are far more durable and less liable to derangement in their action than poppet valves, their advantages for all pumps working under constant pressure ratio, if no counter disadvantage existed, would seem obvious.

Unfortunately, a disadvantage does exist, which, in the case of vacuum pumps designed to effect a very good vacuum, is absolutely fatal, and which seems to be insurmountable. Such a valve cannot be applied to a double-acting pump without an amount of clearance between the face of the valve and the piston which prevents a sufficiently complete discharge of the compressed air. There arrives a time when the air filling this clearance compressed to atmospheric pressure, is enough, when it expands to the lower suction pressure, to completely fill the cylinder together with the clearance space, and suction ceases when this occurs. When this condition is established the limit of the vacuum is reached. But for compressors compressing air from a pressure of one atmosphere to a higher pressure, into a receiver from whence the contained air issues at a uniform rate (as is the case with the blowing engine) I can see no valid objection to this type of valve. In this and analagous cases the air is compressed to a stated pressure, and hence the ratio of compression is practically constant; therefore the point at which the slide on the back of the compressor main valve should uncover the discharge port can be determined with exactness, and the valve gear set to positively attain such opening. In the case of air compression for supplying motors and lifts in a shop, an approximation to a uniform stated pressure can be gained by using a receiver of so large a capacity that a sudden demand for air supply will not materially lower the pressure before automatic regulation is effected.

The compound system of compression, besides other practical advantages, lessens the ill effects of clearance or waste spaces in the compressors by lessening the ratio of compression in each of the compressors used in the system. For this reason much better results are attained in vacuum pumps by compounding than are possible with a single-cylinder pump. But the fact is that only slight decrease of economical efficiency is caused by a moderate clearance in incondensable gas compression from atmospheric pressure to a higher pressure, and that, in pumps for such work, clearance is not the important defect it was once considered to be. A slight increase in the stroke or the diameter of the compressor cylinder, or of both diameter and stroke, will compensate for the diminution of capacity due to expansion of air remaining in the waste spaces after the discharge has ceased, and as this residual air gives back to the piston on the suction side nearly all the power required to compress it, an almost negligible loss of power is sustained.

Probably the poppet suction valve used in some of the single-acting vertical compressors works as satisfactorily as any valve that ever has been, or will be, devised for the purpose. This valve, when working, requires no spring for its closure, neither is gravity concerned in its action. It opens and closes by its *vis inertia* alone. It is, as well-known, placed in the piston instead of in the cylinder head or bonnet, and it is nicely balanced or poised on a coiled spring that supports its entire weight, allowing it, when at rest, to close down almost tight upon a conical seat to which it is nicely fitted by grinding. Now, if we could suppose a perfect vacuum to exist in the cylinder and the piston to have a velocity a little greater than that which the force of gravity would produce from rest in the time required for its movement, the valve would open and remain open during the downward stroke, and close and remain closed during the upward stroke. In actual work the space above the piston fills during the downward stroke, the gas being then transferred from the lower to the upper side of the piston. During this stroke inertia causes the valve to lag behind its seat, and, consequently, to remain open independently of the pneumatic pressure. When the piston reverses its motion at the end of the downward stroke, the valve does not reverse its motion till it meets and closes upon its seat, this action taking place during about four degrees of crankpin revolution over the dead center, and hence being well-nigh instantaneous. These single acting compressors, allowing the use of the well-known safety-head, practically eliminate waste spaces on the compression side of the piston. I believe that, with the single-acting compressor having a perfectly acting piston and tight valves, as fine a vacuum can be produced as can be attained with any apparatus except the mercury air pump. The suction-valve seats accurately without noise, and is easily kept tight; but it can be used in single-acting compressors only, and while with such compressors poppet suction valves give less trouble than on the double-acting, the cylinders must be of nearly twice the diameter with equal stroke to reach the same capacity.

With regard to construction, we have two leading types of compressors,—the single-acting and the double-acting reciprocating compressors—with, possibly, the promise of a third type—turbine compressors, which may be exploited sooner than expected. They are certainly within the range of mechanical possibility, reasoning from the success that has been reached with steam turbines. They will not be concerned with the compressor-valve question.

With regard to their action, we have three classes: compressors which work with a constant pressure ratio, those which work with a constantly increasing pressure ratio, and those which work with alternately increasing and diminishing pressure ratio.

The suction valves of all these compressors may be positively actuated by mechanism, and the discharge valves of the first and third classes may be positively actuated, provided the variable pressure ratio of the third class be reduced as much as possible by means already discussed. Both the first and third classes of compressors may be successfully operated by a single main slide-valve, with a cut-off slide if the pressure ratio varies little in the third class. The second class of compressors must have automatically acting discharge valves to avoid an excessive waste of motive power. The simplest form of automatic valve yet devised for air-compressor work is a poppet valve; but it has many defects. To afford full opening it requires too great lift, and if to avoid this defect a multiplicity of valves be used, defective closing cannot be positively attributed to any one of the valves without an examination of the entire set. Except in the case of the suction valve in the piston of the single-acting compressor, poppet valves are always more or less noisy and wear rapidly under continuous work. Obstructions, such as scale jarred from the interior of pipes, are liable to be trapped between their faces and their seats, and frequently injure the ground surfaces, necessitating regrinding. The springs, unless very carefully made and tempered, are apt to break, in which case a fragment of the broken spring may cause injury. In short, although the poppet valve may be the best automatic valve yet available, many an engineer has longed for something which would save the care required to insure its efficient operation.

The ideal valve is one that never leaves its seat. Of valves which in action remain constantly seated, we have the types of the common locomotive slide, the rotary, the piston valve, the oscillating rotary (of which the Corliss valve is the prime favorite) and a large variety of gears for positively actuating each of these types. The grid variety of slide valves and the piston valve can be made to give a large valve opening with less motion than others, and large suction-valve opening is essential to progress if smaller compressors with higher piston speeds are ever to take the place of the present machines. Proceeding from these types, there may yet be evolved valves reasonably satisfactory in meeting the requirements of each of the three classes of compressors; but the difference in these requirements seems to preclude the hope that any one kind of valve will answer for the entire category. But in our age of rapid progress who will venture to assume the *rôle* of a prophet?

THE EFFECTS OF VACUUM ON STEAM-ENGINE ECONOMY.

By R. M. Neilson.

With this article Mr. Neilson concludes his discussion of some of the most important factors in steam-engine economy. The review began in our issue for March last, and after devoting two papers to the subject of superheated steam, followed in May and June with a consideration of the economy of condensing, and the principal types of condensers and their operation. The concluding section, now presented, completes the discussion of condensing systems and the auxiliary machinery of the condensing plant.—The Editors.

IF the water supply is scarce, condensing is in many cases only possible by using much less water than is usually required for surface, jet, or ejector condensers. Even if the water supply is plentiful, it may be (and is in many cases) so expensive that no financial gain can be got from condensing unless the consumption is restricted by employing some form of evaporative condenser or some re-cooling device for the condensing water.

We can greatly reduce the consumption of condensing water by using the same water over and over again, supplying continually or intermittently a little fresh water to make up for losses by leakage and evaporation. This means that we must have cooling tanks or cooling towers or the like for the water. Cooling towers are arranged to expose a large surface of water, and are as a rule to be preferred to tanks or ponds, as they take up much less ground area and as a rule cost less to begin with, although the upkeep of a tower may be greater than that of a well constructed tank or pond. Sometimes the tower is closed in and air is mechanically propelled against or over the water in the tower so as to increase the rate of cooling of the water. This allows a much smaller tower to be employed, or the water to be cooled to a lower temperature with the same size of tower. Where the available ground area for a tower is restricted or where it is desired to obtain condensing water at a temperature approaching that of the atmosphere, this mechanical ventilation may be very useful. As a rule, however, it pays better to dispense with it, as the fan, to make much impression, will absorb as much power as the air and circulating pumps put together. Sometimes the tower is closed in but no fans employed, a chimney being arranged over the tower so as to produce a natural draught. This arrangement

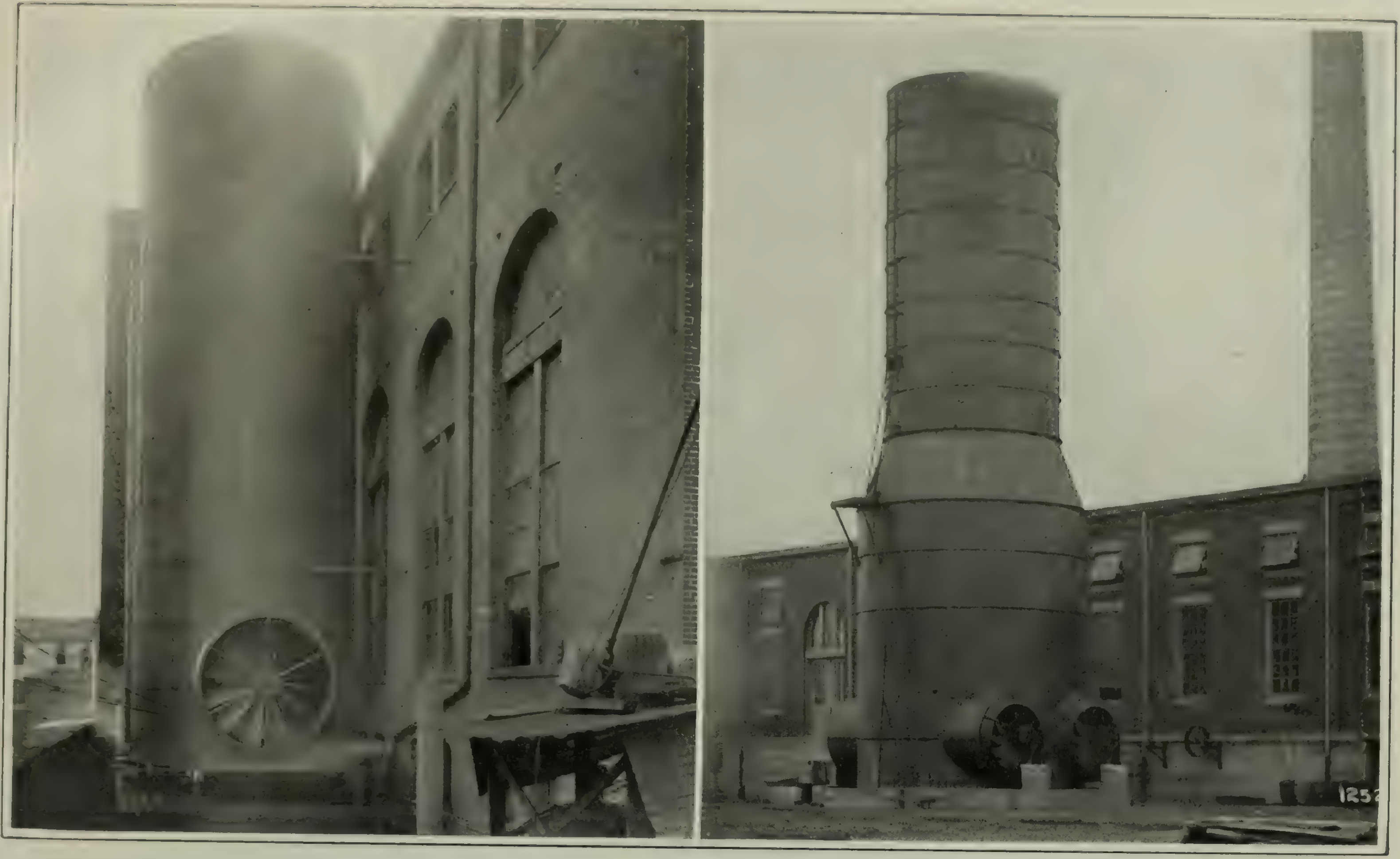


FIG. I. TYPES OF FAN-COOLED COOLING TOWERS.

On the left, a group of five cooling towers for the Georgia Railway & Electric Co., Atlanta, Ga.; hourly capacity, 55,000 gal. each; built by George J. Stocker, St. Louis, Mo.; on the right, a combination natural and forced-draught tower at the Worthington Hydraulic Works, Harrison, N. J.; 26-ft. diameter base, 85-ft. high; four 108-in. fans; normal rating, 65,000 lb. steam per hour. A water seal, determined by the level of the overflow, closes the bottom when forced draught is to be used. International Steam Pump Co.

may be considered intermediate between the fan-cooled tower and the open tower and occupies floor space intermediate between the two. The floor space of course varies according to the nature of the tower, the temperature at which the water is received and discharged, and the temperature of the atmosphere. Generally speaking, these towers require a floor space of ½ square foot to 2 square feet per horse power of engines served. A fan-cooled tower absorbing about 2 to 4 per cent. of the power of the engines served, occupies with its fans and motors (roughly speaking) about one-third of the area required by an open tower.

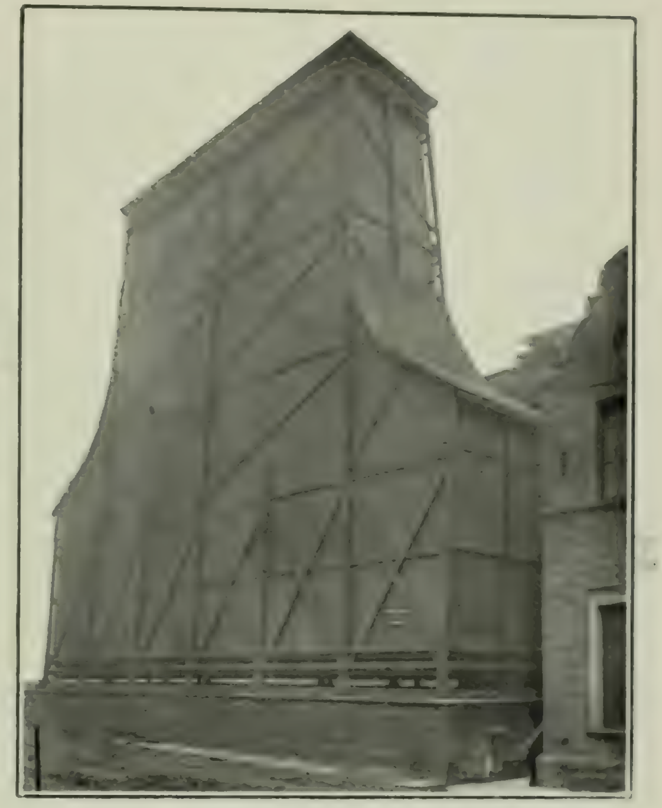


FIG. 2. NATURAL-DRAUGHT COOLING TOWER
Klein Engineering Co., Ltd.

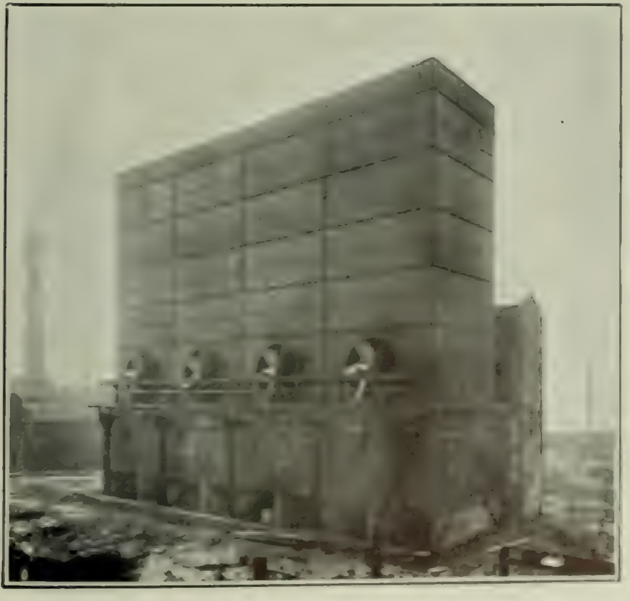


FIG. 3. FAN-COOLED TOWER ERECTED ON TOP OF TANK.
Klein Engineering Co.

Figure 2 shows a natural-draught cooling tower constructed by the Klein Engineering Company, Ltd., of Manchester, for use at an electricity works. The lower part of the structure is filled with wooden frames. The water to be cooled is raised to a height of about 25 feet and delivered into a main trough situated at the top of the frames.

From this main trough the water flows by way of distributing troughs into a series of small gutters which discharge it so that it flows down the frames. The water is exposed in thin films to the cooling action of the air and loses heat partly to the air and partly by evaporation. The tower is closed in by a wooden casing, braced as shown.

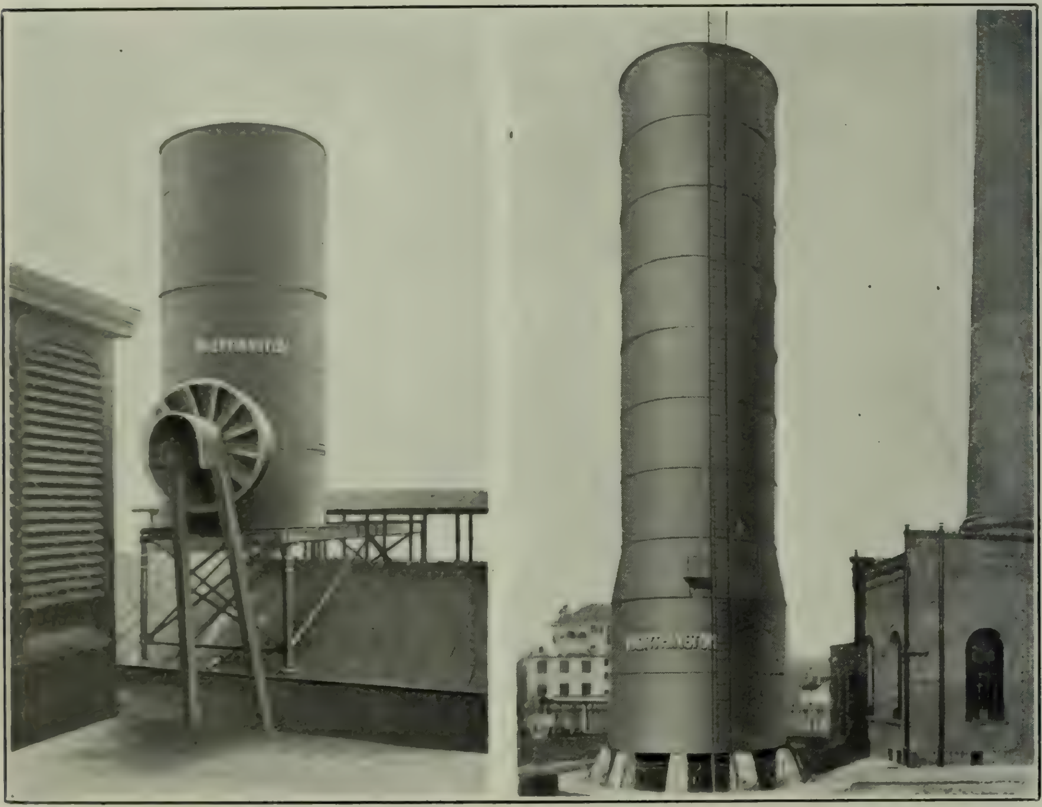
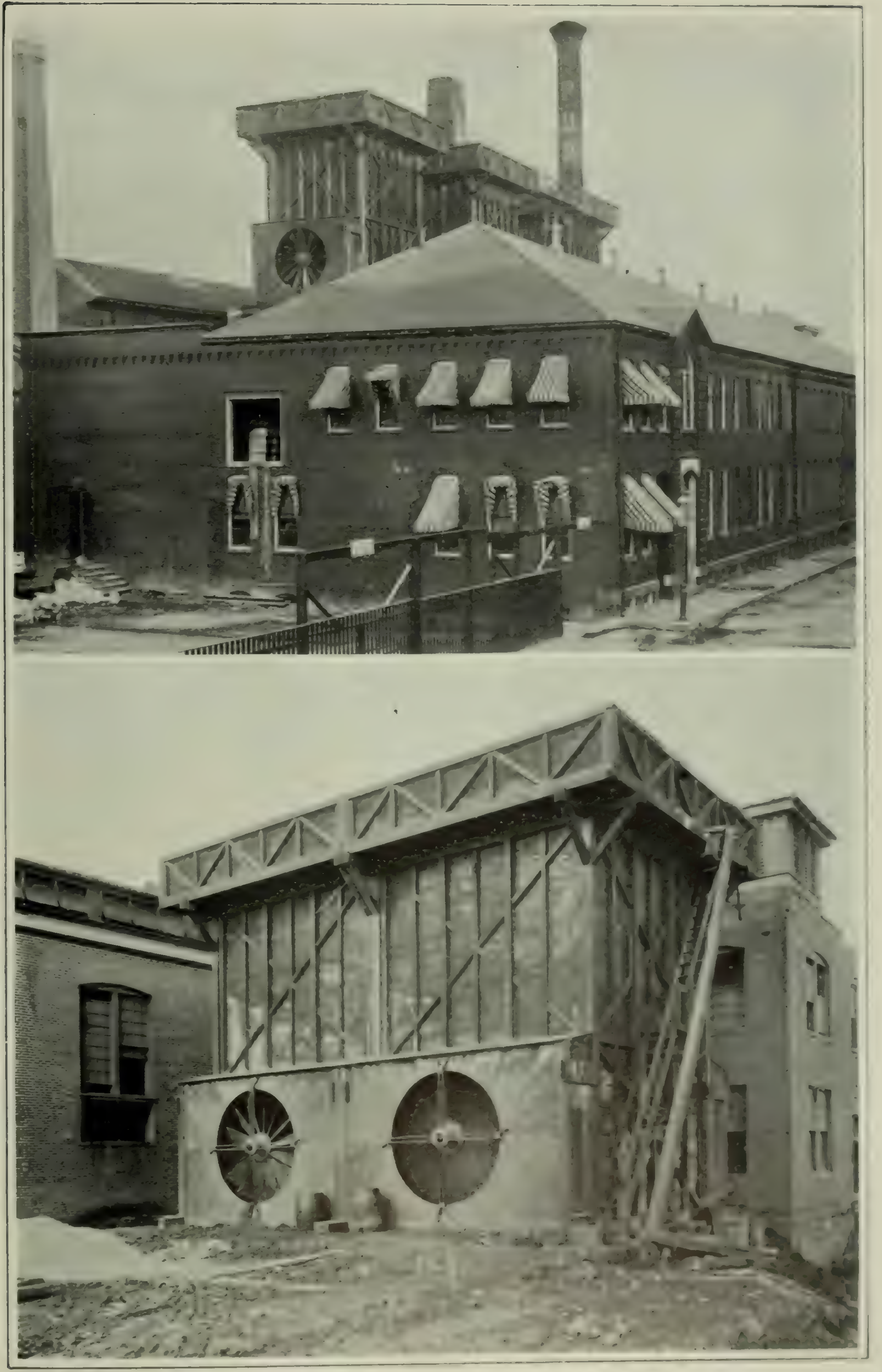


FIG. 4. EXAMPLES OF COOLING-TOWER INSTALLATIONS.

That on the right is fan-cooled; that on the left—at a German power plant—is cooled by natural draught. International Steam Pump Co.

Figure 3 illustrates a Klein fan-cooled tower. Eight fans are employed—four at each side of the tower. By these fans air is forced into the tower, a guiding plate being arranged in the centre of the tower to direct the currents of air from the two sides upwards. The fans are driven by electric motors. This particular cooling tower, to suit local requirements, was erected as shown on a steel-girder framework at a height of about 20 feet above the ground, and with a cast-iron tank to collect the cooled water. This causes it to look considerably higher than it otherwise would. The capacity of this tower is 400,000 gallons of water per hour.

Another means of reducing the consumption of condensing water is to employ an evaporative condenser. In this the condensing water,



EXAMPLES OF COOLING-TOWER INSTALLATIONS.

Above, a group of three towers of 750,000 gal. capacity each, erected on roof of Commonwealth Hygienic Ice Co., Boston, Mass., by George J. Stocker, St. Louis, Mo. Below, a double tower of 1,600,000 gal. per day capacity, built by the same maker for the Polar Wave Ice & Fuel Co., St. Louis.

while condensing the steam, has a large surface exposed to the atmosphere and its cooling effect is increased by its withdrawing heat from the steam (to be condensed) to evaporate part of itself. Evaporative condensers can be run on one pound of condensing water per pound of steam condensed, giving a vacuum of 22 inches to 24 inches of mercury. They are often run on less water than this. No more water need therefore be used for running an engine condensing with an evaporative condenser than in running the engine non-condensing.

Figure 6 shows an evaporative condenser supplied by Messrs. Ledward & Beckett, Ltd., of London, to the Midland Iron Co., Ltd., of Rotherham. This condenser is designed to be able to deal with 20,000 pounds of exhaust steam per hour. The steam to be condensed is led to the top of the condenser and zig-zags downwards through the horizontal pipes. Condensing water is led to the top of the apparatus and trickles down the outside of these pipes. The pipes are fitted with annular ribs which serve to increase very largely the cooling surface. The pipes are bolted together with flanged faced joints.

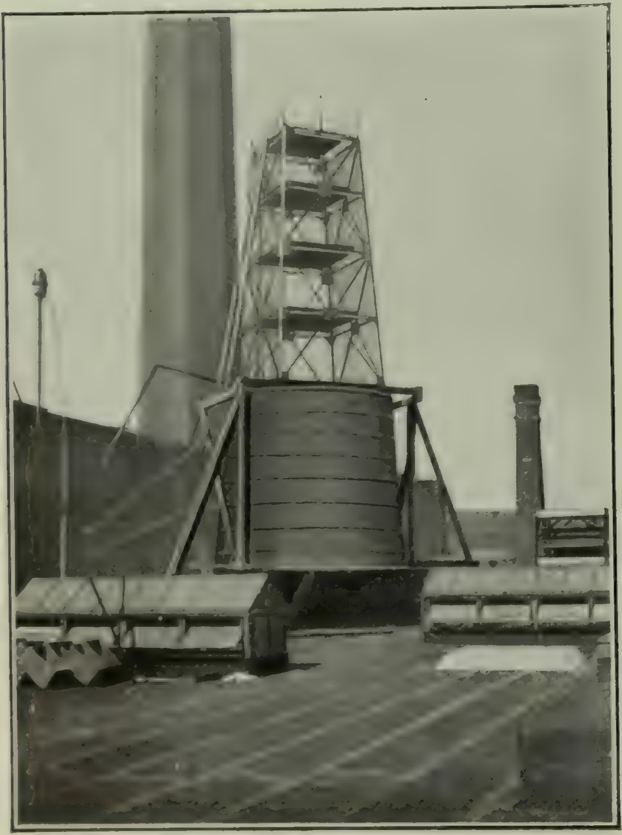


FIG. 5. ACME COOLING TOWER, REFRIGERATING PLANT OF SHEFFIELD FARMS-SLAWSON-DECKER CO., NEW YORK.

Capacity—100 gallons a minute. Built by B. Franklin Hart, Jr., & Co, N. Y.

In order to obtain a good vacuum for steam turbines with a moderate sized condenser and air pump, the Hon. C. A. Parsons has invented a vacuum augmentor. This consists of a steam jet situated in the duct which leads the air and vapor from the condenser to the air pump, and which jet by an injector action helps to draw the air and vapor from the condenser and maintains a lower pressure in the condenser than at the inlet to the air pump. Figure 8 shows a con-

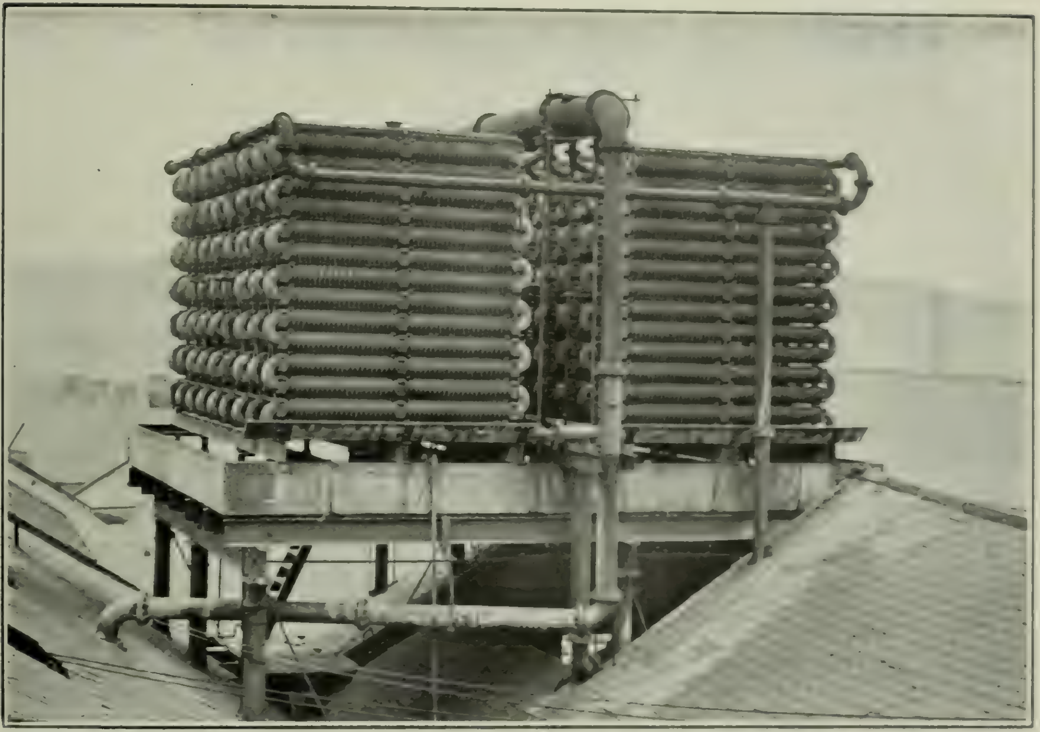


FIG. 6. LEDWARD EVAPORATIVE CONDENSER ERECTED AT THE WORKS OF THE MIDLAND IRON CO., LTD., ROTHERHAM.
Capacity—20,000 lb. of steam per hour.

densing plant arranged with this vacuum augmentor. The inlet to the air pump is situated about 3 feet below the bottom of the condenser. The air and water leave the condenser separately, and the air on its way to the air pump passes through an auxiliary condenser which has about one-twentieth of the cooling surface of the main condenser. The steam jet is placed, as can be seen in the figure, between the main auxiliary condensers. This vacuum augmentor with a steam consumption of one per cent. of that of the turbine may increase the vacuum into which the engine discharges from 26 to 27½ or 28 inches, the air pump acting however as if the vacuum was only 26 inches. Figure 9 shows the effect of the augmentor on the steam consumption of a 1,500-kilowatt Parsons turbine. It should be particularly noted that the cooling water used was at the somewhat high temperature of 85 degrees F. The consumption of cooling water was thirty times that of the exhaust steam at full load. The steam used by the jet amounted at the tests to 450 pounds per hour and this has been added to the steam consumed by the turbine in drawing the curves which represent steam consumption with the augmentor in use in Figure 9.* The consumption of steam by the jet has since been considerably reduced.

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* Paper read by the Hon. C. A. Parsons and Messrs. G. G. Stoney and C. P. Martin before the Institution of Electrical Engineers (Great Britain), May, 1904.

Sometimes exhaust steam from non-condensing engines is used for heating workshops and factories in which or near which the engines are located, or for heating liquids in chemical or other works. In such cases, in considering the advisability of condensing, we have to take into account the cost of heating by other means in place of by the exhaust steam. The exhaust steam from turbines is especially advantageous in many cases owing to its freedom from oil. Similarly, if we wish to compare a non-condensing engine, the exhaust steam from which is used to heat the feed water to say 200 degrees F., with a condensing engine, we must allow for the fact that the condensing engine will provide feed water from the hot well at a considerably lower temperature than 200 degrees F.

The importance of getting cheap condensing water for large power stations employing steam engines will be appreciated by considering the amount of condensing water required by a large power station. The condensing water required by each of the large reciprocating engines at the power station of the New York Rapid Transit

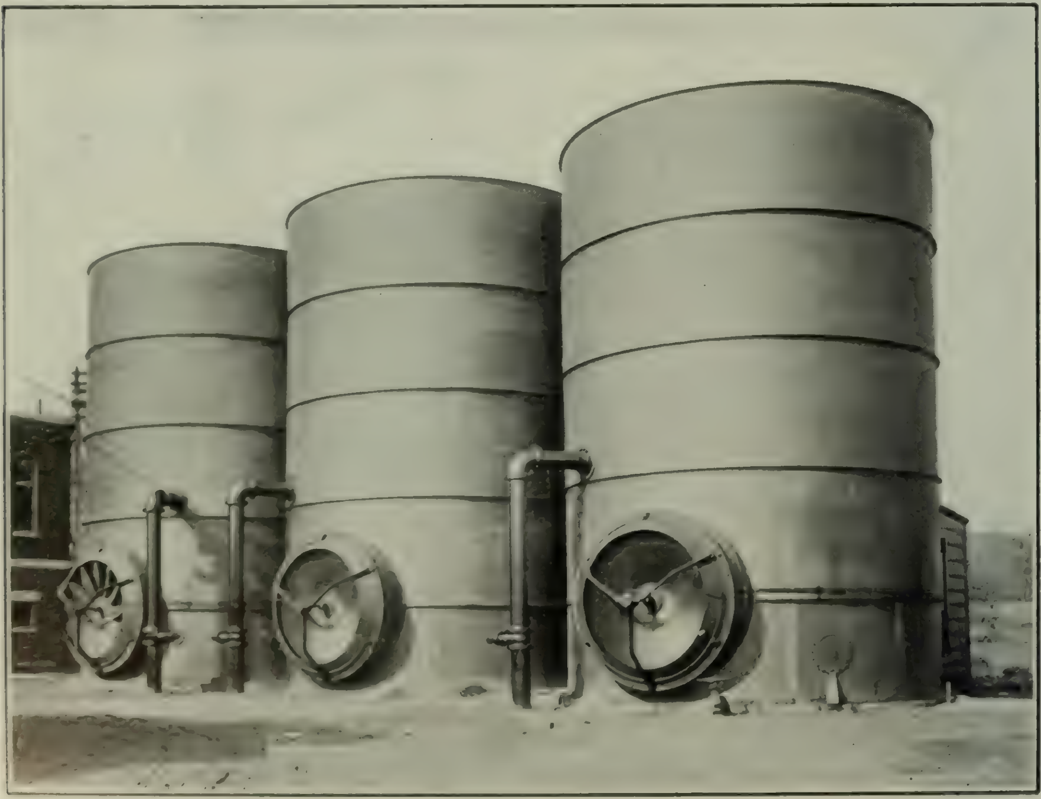

FIG. 7. COOLING TOWERS AT POWER HOUSE OF BOSTON & WORCESTER STREET RAILWAY CO., FRAMINGHAM, MASS.

Designed to cool the water for an Alberger counter-current condenser handling the steam from a 2,000-kilowatt Curtis turbine. Vacuum 27 inches. Each tower has two fans, driven by electric motor. Alberger Condenser Co., New York.

Subway amounts to about 400,000 gallons per hour when the engine is working at its maximum capacity, and there are nine such engines besides steam turbines. The vacuum pumps of this station are illustrated on the following page.

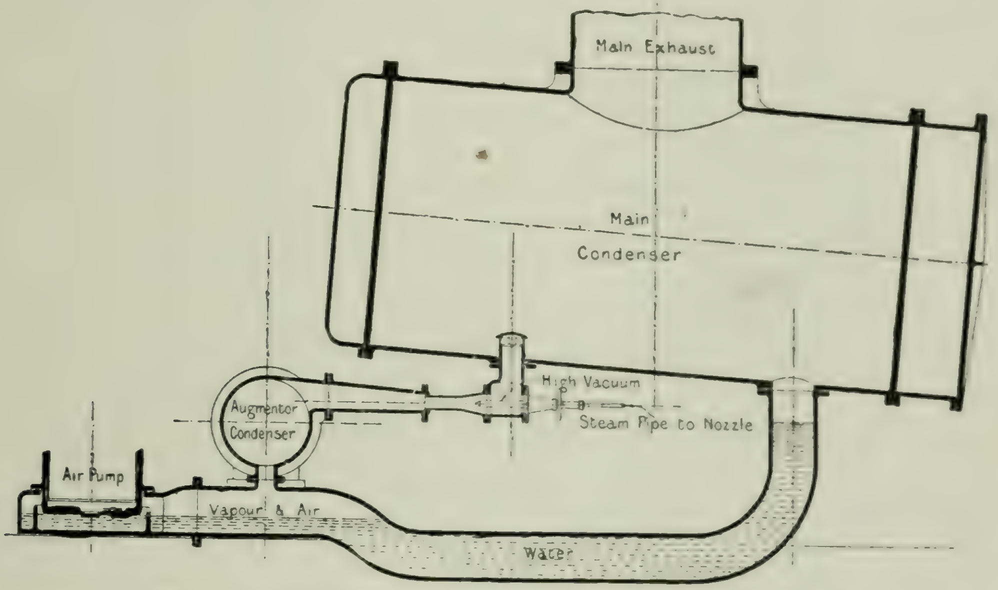

FIG. 8. ARRANGEMENT OF PARSONS VACUUM AUGMENTOR.

An important question to be considered in deciding on the condensing plant for power stations employing several units is as to whether each unit should be provided with a separate condenser or

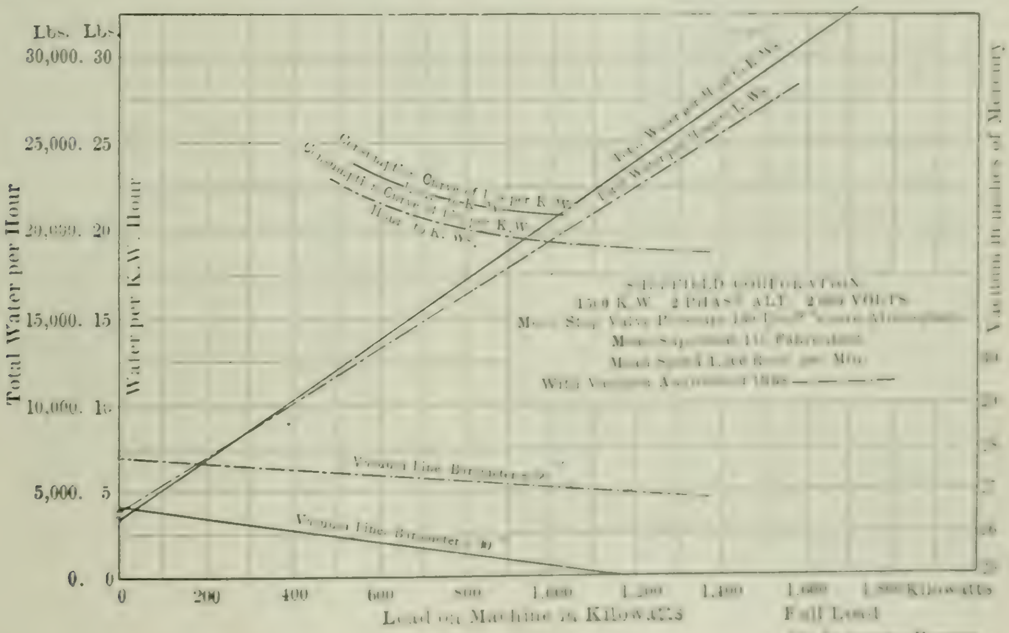

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FIG. 9. SHOWING THE EFFECT OF A PARSONS VACUUM AUGMENTOR IN IMPROVING THE VACUUM AND REDUCING THE STEAM CONSUMPTION OF A STEAM TURBINE.

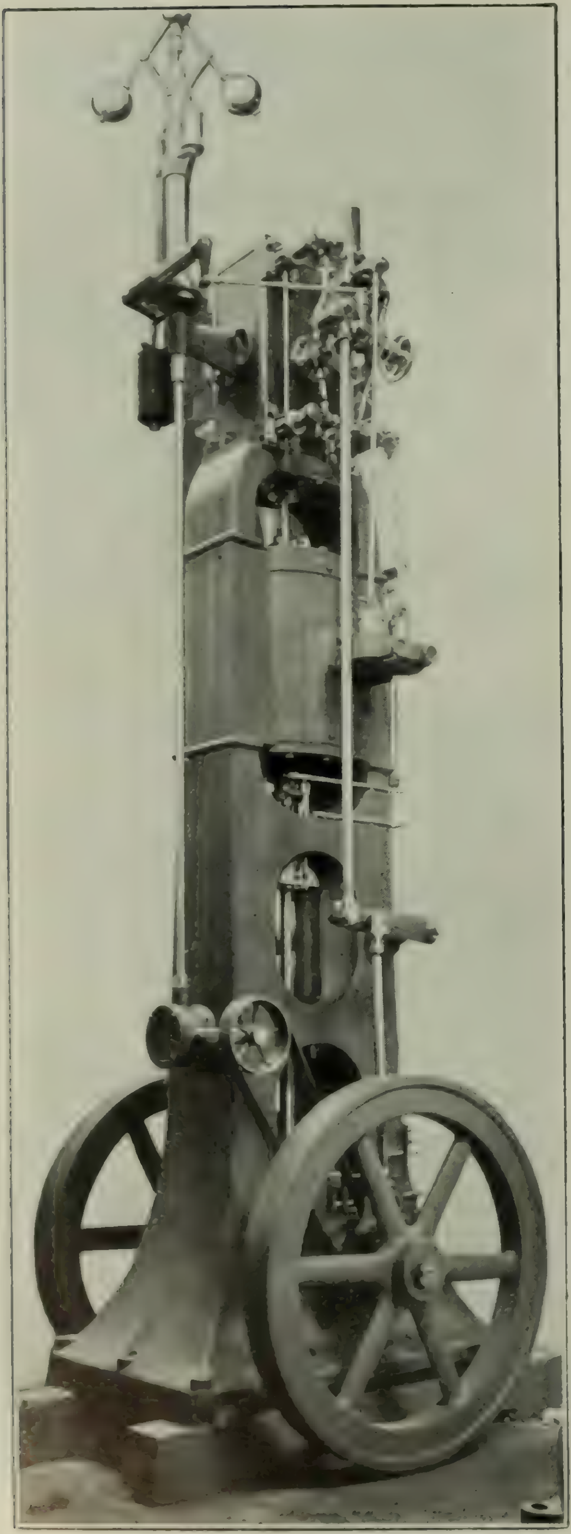
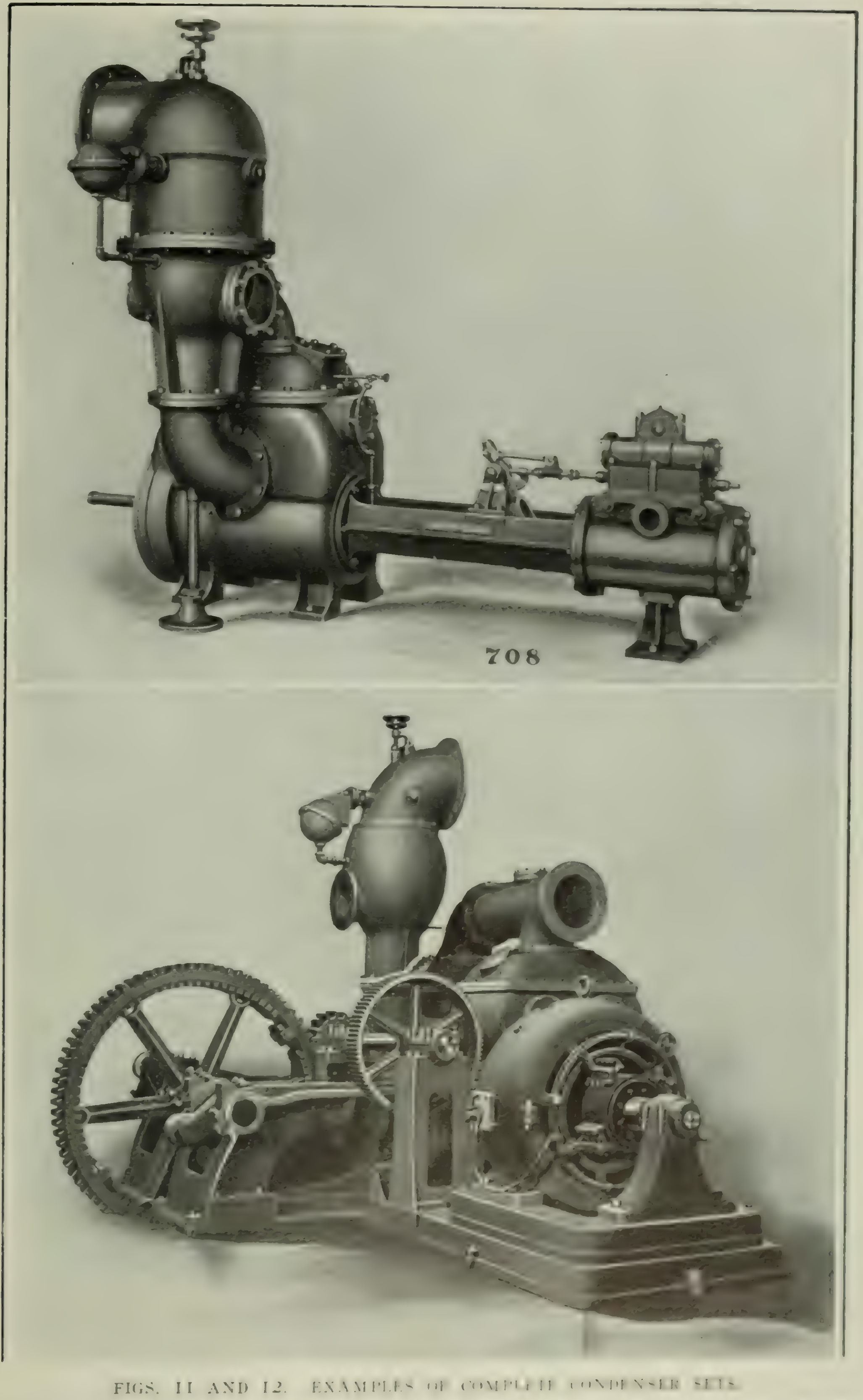


FIG. 10. VERTICAL DRY VACUUM PUMP. One of eight installed in 59th St. ("Subway") power house, Interborough Rapid Transit Co., N. Y., used in connection with Alberger barometric condensers attached to reciprocating engines of 10,000 h. p. each. Alberger Condenser Co., N. Y.

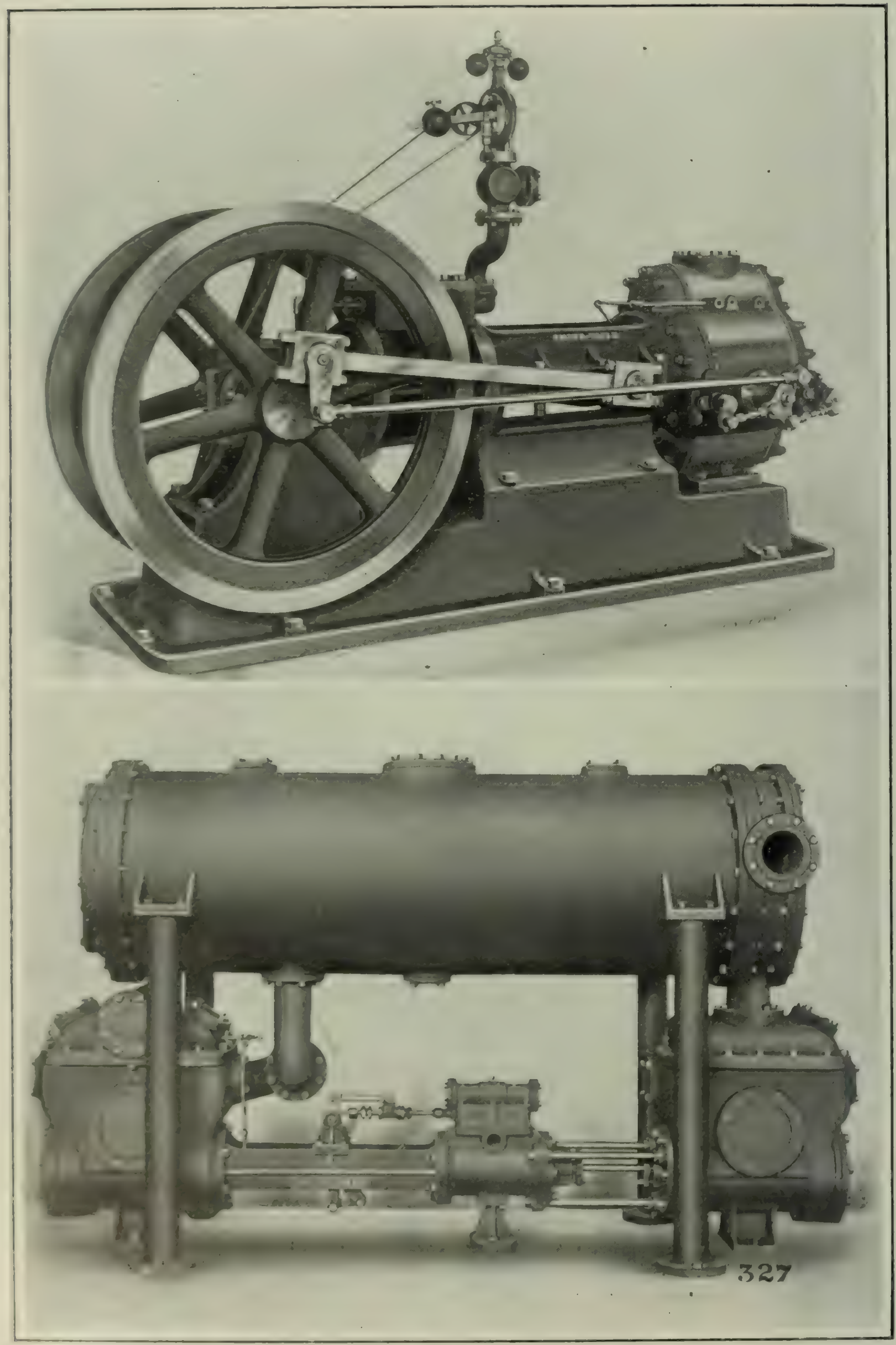
whether a centralised condensing plant should be installed to serve for all the units. There is a saving to be derived from employing a centralised plant, especially where the units are of small or moderate dimensions. One objection to the employment of a centralised plant is that, if any mishap occurs to this, all the engines are affected, whereas a mishap to a single condensing plant where each engine has its own, affects of course only one engine. The use of a centralised condensing plant does not however involve the risk of having all the engines stopped, as would be the case if all the engines got their steam from one boiler and that boiler was put out of action. Each engine should be provided with means for exhausting into the atmosphere whenever necessary.

In many cases where each engine has its own condensing plant it is advantageous to cause the engine to drive the air and circulating pumps. In other cases, however, this is not at all good practice. With rolling-mill engines, winding engines for pits, and other engines in which the full load comes on almost instantaneously when the engine is



FIGS. 11 AND 12. EXAMPLES OF COMPLETE CONDENSER SETS.

The upper figure is a Smith-Vaile single jet condenser; the lower, a duplex motor-driven jet condenser. Both are made by The Platt Iron Works Co., Dayton, Ohio.



FIGS. 13 AND 14. CONDENSER INSTALLATIONS AND AUXILIARIES.

The lower figure shows a surface condenser combined with air and circulating pump. The upper shows a dry vacuum pump furnished for installation with surface and barometric tube condensers. The Platt Iron Works Co., Dayton, Ohio.

started, it is very important if condensing is employed to have the air and circulating pumps independently driven so that the main engine can start with a good vacuum.

Prof. Rateau is responsible for a scheme which is in use at the Bruay Collieries (Pas de Calais) and which appears to give good results. The winding engines all exhaust at atmospheric pressure, and the steam is conveyed from each engine to a central accumulator which supplies the steam continuously at about atmospheric pressure to a steam turbine employed to drive an electric generator. The accumulator is filled partly with steam at the saturation point and partly with water on the point of boiling. The steam and water have a large surface of contact; and the consequence is that a small rise or fall of pressure in the accumulator due to the intermittent nature

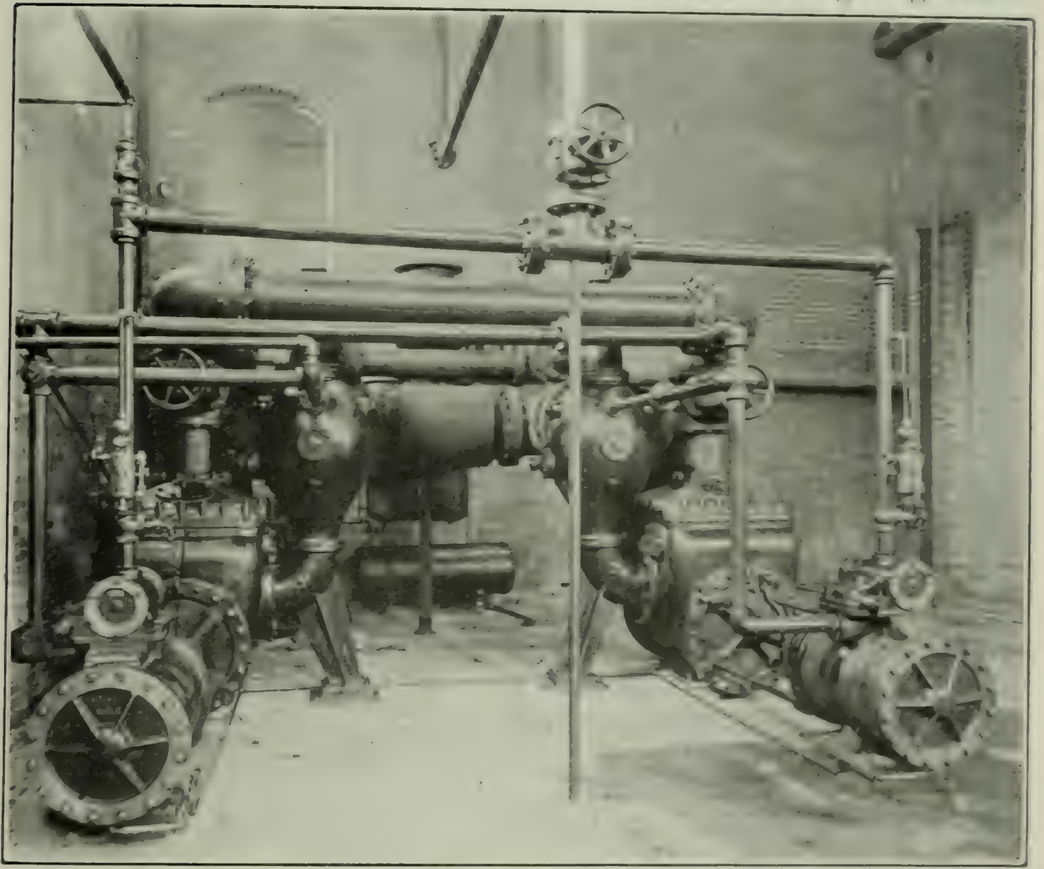


FIG. 15. TWO UNIT CONDENSER INSTALLATION, STANDARD SANITARY MFG. CO., NEW BRIGHTON, PA.

Two 18 x 22 x 24 Burnham jet condensers, taking care of condensation from one Corliss engine 20 by 42; two Skinner compounds 13½ by 24 and 10½ by 19 by 18; one compound high-pressure air compressor, 15 by 28 by 16, and one non-compound compressor, 14 by 18. All steam at 125 lb. Average temperature of condensing water 80° F. Average capacity of each condenser 20,000 lb. per hour. Installation by Union Steam Pump Co., Battle Creek, Mich.

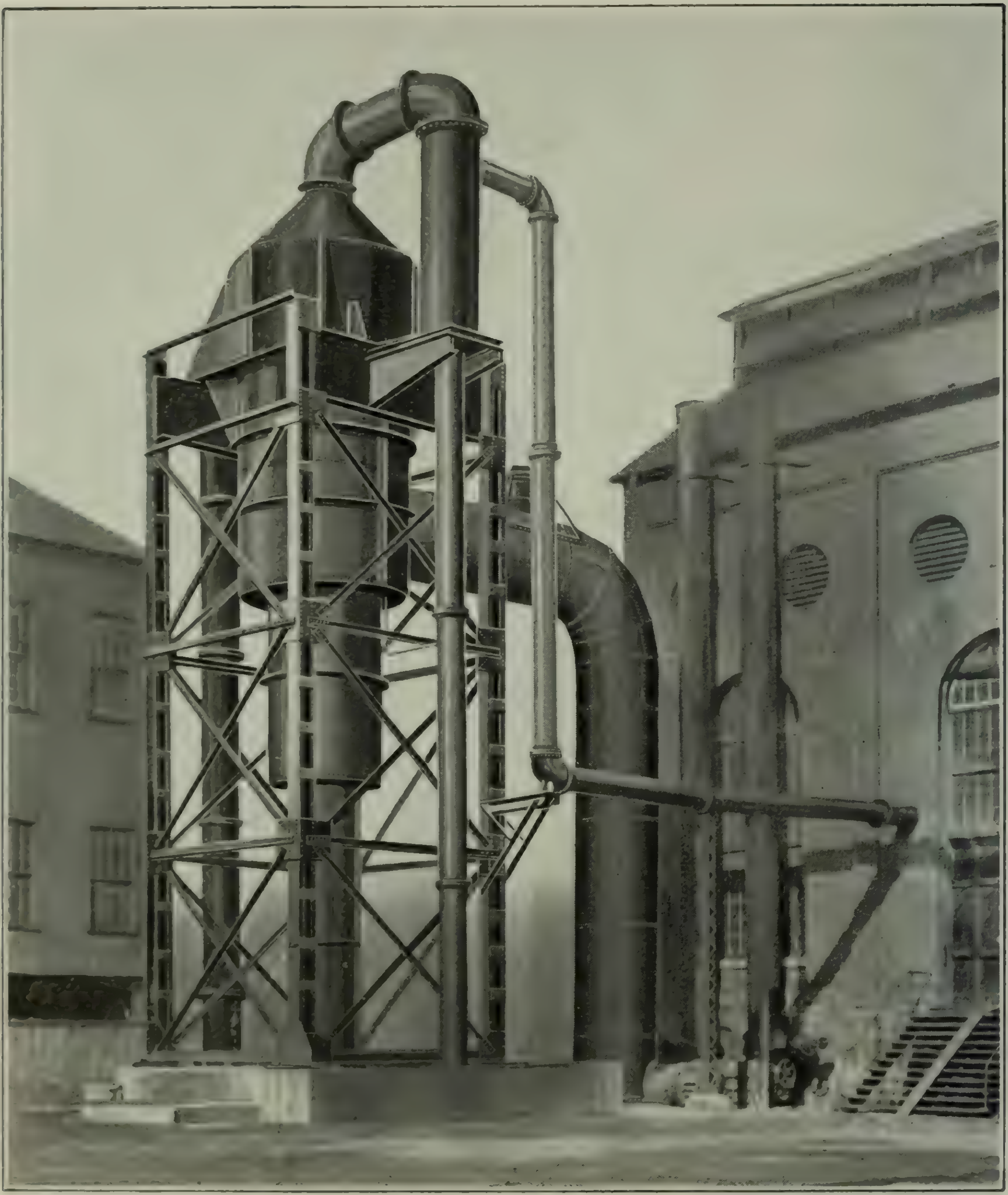


FIG. 16. WEISS CENTRAL COUNTER-CURRENT CONDENSER, SOUTH WORKS OF ILLINOIS STEEL CO., CHICAGO, ILL.

Capacity 30,000 lb. of exhaust steam per hour. Built by Southwark Foundry & Machine Co., Philadelphia, Pa.

of the supply of steam from the winding engines causes steam to condense or water to evaporate so that the turbine can receive a continuous supply of steam, although this varies a little in pressure.* An arrangement like this is preferable to running the winding engines

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* See paper by Prof. Rateau read before the North of England Institute of Mining and Mechanical Engineers at Newcastle-on-Tyne, Dec. 13th, 1902, or paper by the same author read at the Chicago joint meeting (1904) of the Inst. of Mech. Engineers (Great Britain) and the American Society of Mechanical Engineers.

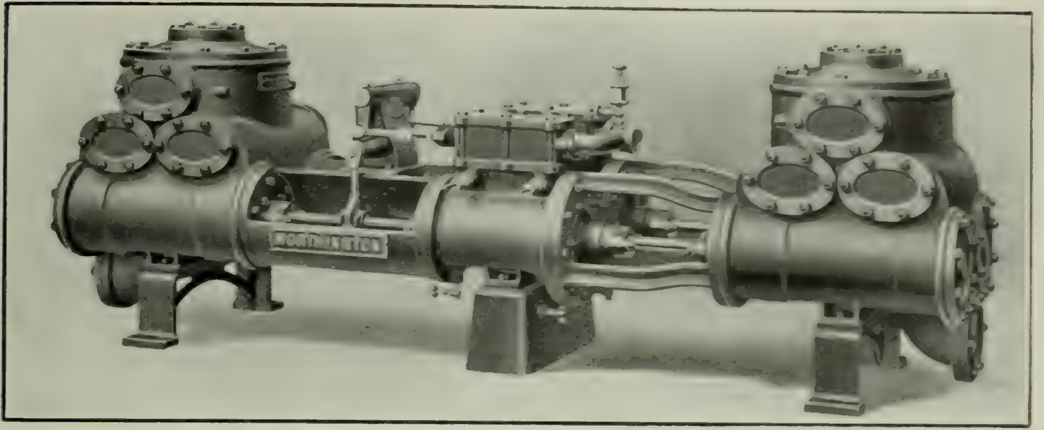

FIG. 17. WORTHINGTON AIR AND CIRCULATING PUMP.

One steam end drives both pumps. International Steam Pump Co., New York.

condensing and employing a centralised condensing plant, in so far that much smaller exhaust pipes are required; and this scheme is therefore practicable in many cases where it would hardly pay to convey the steam from the several engines to a centralised condenser. Even in power stations, the great amount of large diameter piping required for a centralised condenser is a serious objection.

The power required to drive the air and circulating pumps of the condensing plant of a large engine (above 500-horse-power) to give the engine an exhaust pressure corresponding to vacuum of 27 inches of mercury with the barometer at 30 should be under 3 per cent of the effective power of the engine, and in many cases a better vacuum

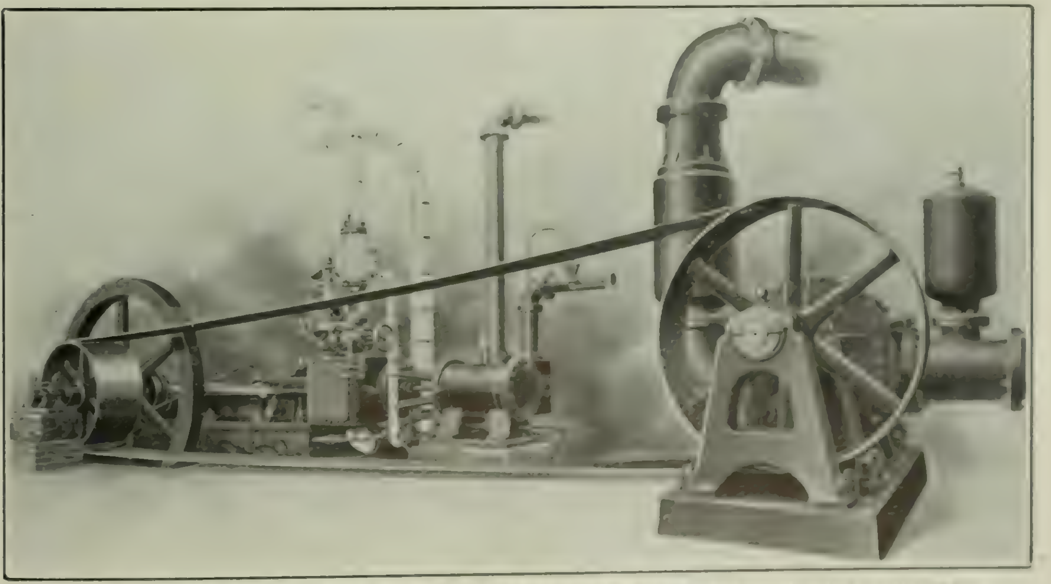

FIG. 18. STANDARD OUTFIT OF AUXILIARY MACHINERY FOR WEISS COUNTER-CURRENT CONDENSERS.

Built by Southwark Foundry & Machine Co., Philadelphia.

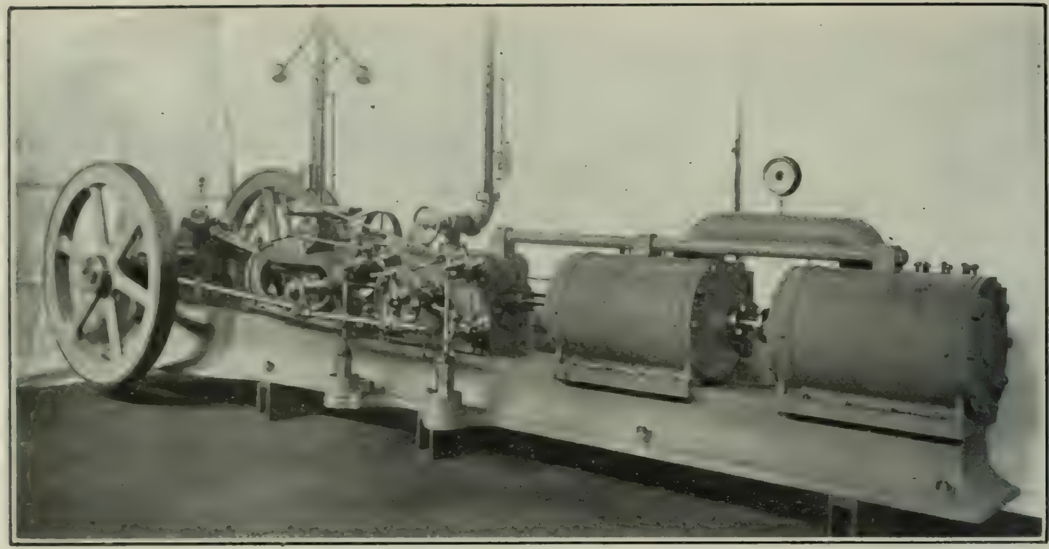

FIG. 19. CORLISS TWO-STAGE DRY VACUUM PUMP.

Used with condensers of both surface and barometric type. Vacuum cylinders compounded to enhance efficiency. Alberger Condenser Co., N. Y.

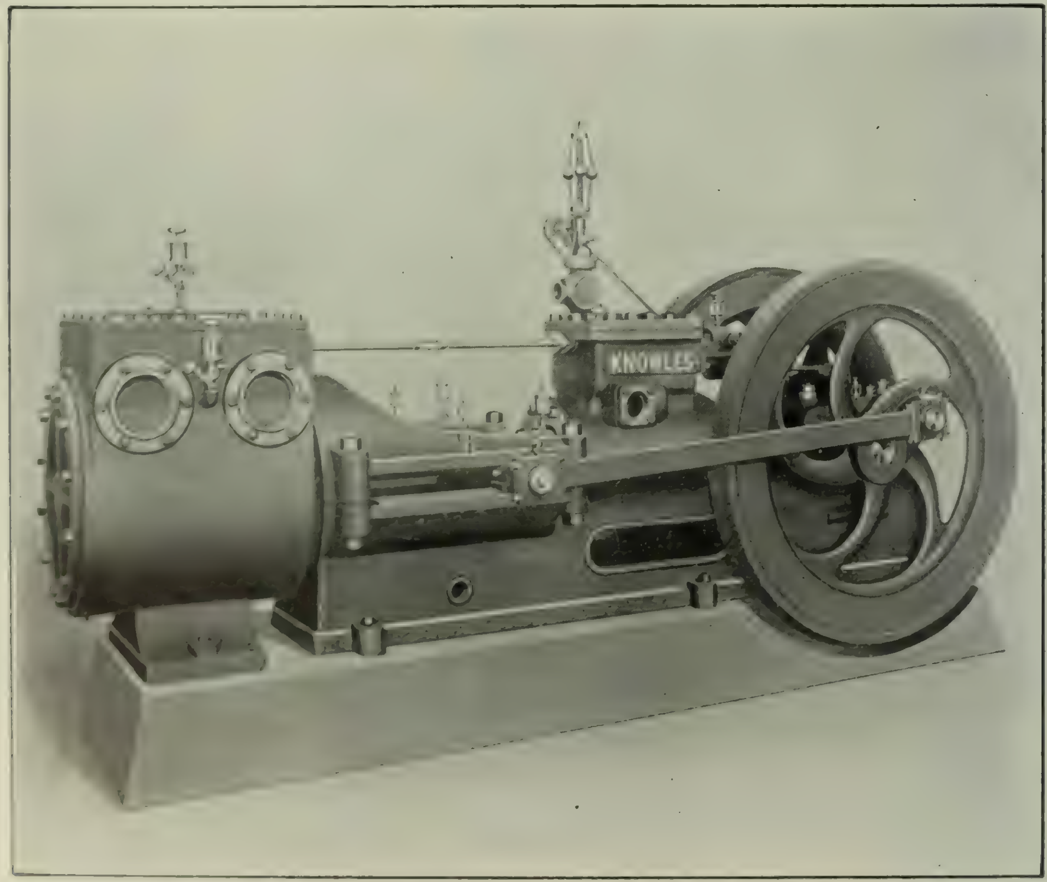

FIG. 20. ROTATIVE DRY VACUUM PUMP.

Adapted particularly to central condensing systems. Suction valves of vacuum cylinder positively actuated by eccentrics. Vacuum cylinders cooled by water jackets. For high steam pressures the steam cylinders are provided with Meyer cut-off valves. International Steam Pump Co., New York.

than this is obtained with an expenditure of only about 2 per cent. of the effective power of the engine. The power absorbed by the pumps increases very rapidly as the height of the mercury column representing the vacuum in the condenser approaches the height of the barometer. This is especially the case if the temperature of the cooling water is high. An increase of vacuum from 24 inches of mercury to 28 inches when the barometer is at 30 inches may easily double the power absorbed by the pumps, and with high-temperature water it will more than double this.

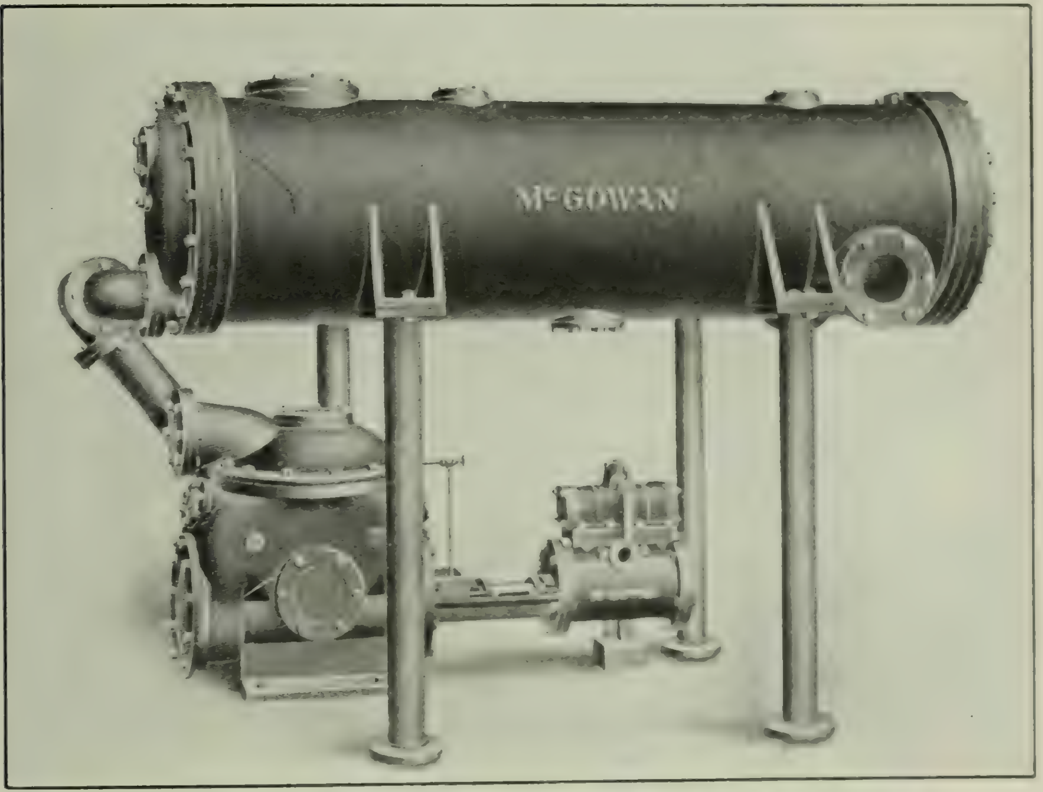

FIG. 21. CENTRALIZED CONDENSING INSTALLATION FOR TWO PUMPING ENGINES. Steam-tube type, 650 sq. ft. tube surface, in combination with 8 by 12 by 12 single air pump. Cooling water may be by-passed from discharge lines of either or both pumping engines, permitting operation of either one singly. Condenser is of capacity sufficient for both at full load. Installed at Bessemer, Ala., water works plant by John H. McGowan Co., Cincinnati, Ohio.

In cases where water for condensing purposes has to be pumped up a considerable height, part of the power required for raising the water may be obtained by utilizing its energy after discharge from the condenser to drive a turbine or water wheel. This may allow of a considerable saving in the cost of working and may permit condensing engines to be employed with advantage in cases where they otherwise could not. This plan was adopted in connection with the

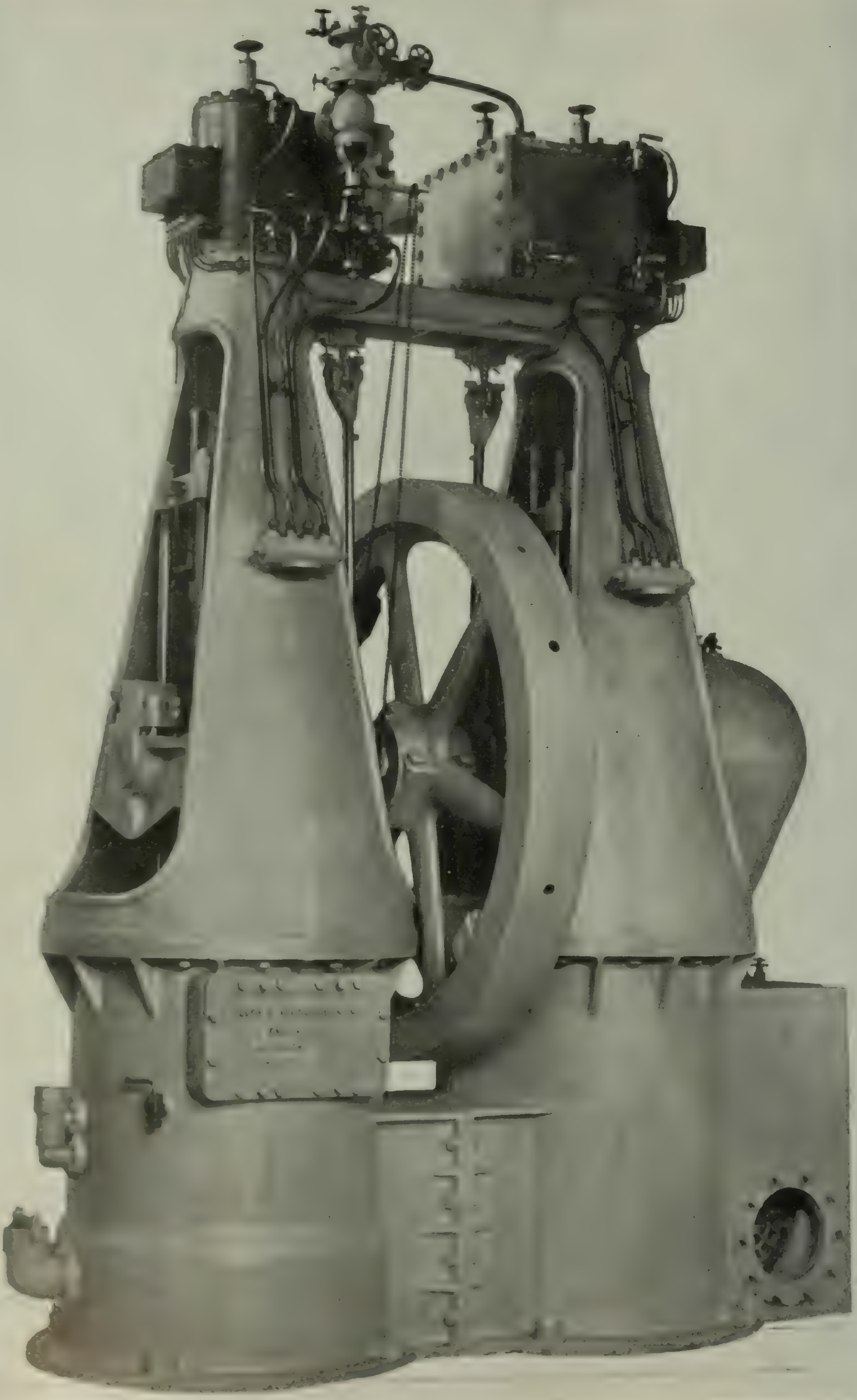

FIG. 22. CIRCULATING PUMP AND EDWARDS AIR PUMP DRIVEN BY COMPOUND STEAM ENGINE.

Alley & Maclellan, Ltd., Glasgow.

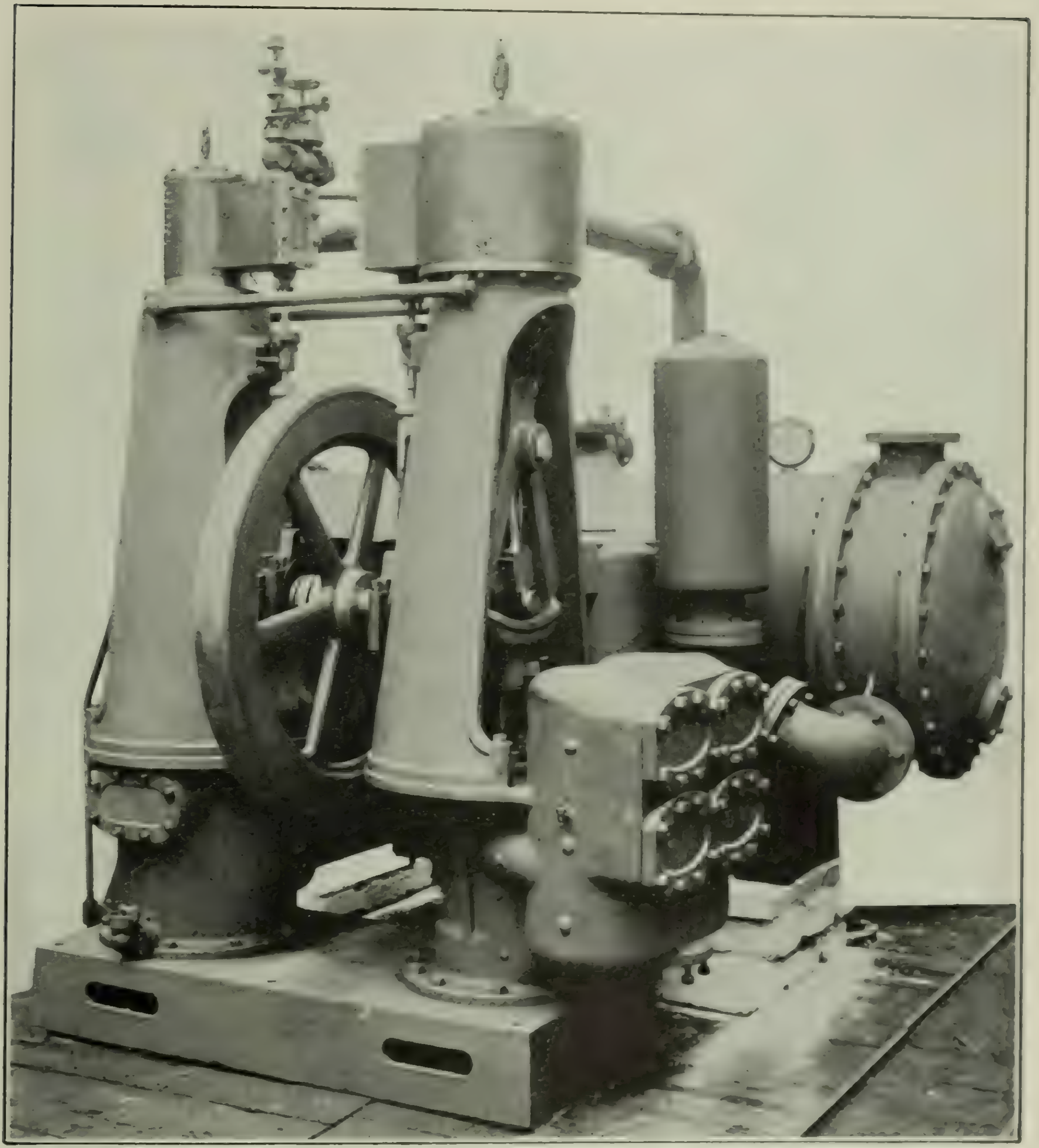

FIG. 23. STEAM-DRIVEN AIR AND CIRCULATING PUMP.

Frank Pearn & Co., Ltd., Manchester.

Newcastle-on-Tyne Tramway Power Station, where the condensing water is pumped up from the River Tyne to the engine room, a vertical height of 86 feet. Centrifugal pumps are employed, each being direct coupled to and driven by an electric motor and a hydraulic turbine. Tests made on one set (pump, turbine and electric motor) at the makers' works (Messrs. Mather & Platt's) seemed to show that about 43 per cent. more electrical energy would have been required if the turbine had not been used.*

Some pumps have already been described. Figure 22 shows a

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* Paper read by Chas. Hopkinson before the Inst. of Mech. Engineers, July, 1904.

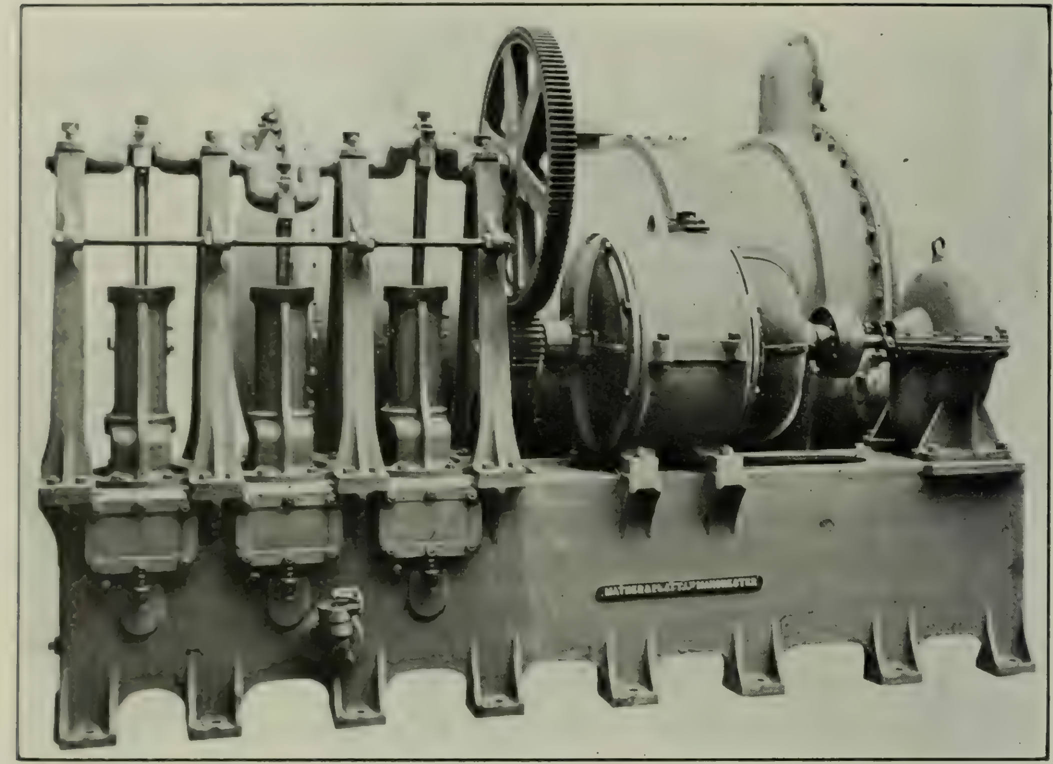


FIG. 24. SURFACE CONDENSER WITH EDWARDS AIR PUMP AND CENTRIFUGAL CIRCULATING PUMP.

Mather & Platt, Ltd., Manchester.

set of air and circulating pumps manufactured by Messrs. Alley & McLellan, Ltd., of Glasgow, to work with a surface condenser for the Sunderland Corporation Electric Lighting Works. The pumps are steam driven, the steam cylinders being seen at the top of the figure, and the pump cylinders at the bottom. The larger-diameter pump cylinder is the air pump. This is of the Edwards type and is 29 inches in diameter and 14 inches stroke. The other pump is for circulating the condensing water. It is double-acting and is 21 inches in diameter and 14-inches stroke. The compound steam cylinders work on the same crank shaft, which makes 60 revolutions per minute. The condenser has 4,000 square feet of cooling surface and is intended to deal with 30,000 pounds of steam per hour.

Figure 23 shows a set of steam-driven air and circulating pumps built by Messrs. Frank Pearn & Co., Ltd., of Manchester. The air pump is seen to the left and the circulating pump to the right, the two pumps being rigidly connected together and having a common crank shaft.

In Figure 24 is illustrated a surface condenser fitted with a three-throw Edwards air pump (seen to the left) and a centrifugal circulating pump (seen to the right). This set was constructed by Messrs. Mather & Platt, Ltd., of Manchester, for a cold-storage warehouse. Both air pump and circulating pump are driven by the same electric motor, the former through gearing and the latter directly.

It is a pity that condenser pressures are usually expressed in inches of mercury of vacuum instead of as absolute positive pressures. A statement that the vacuum in a condenser or in the exhaust pipe from a steam engine corresponds to say 26 inches of mercury, lets us know only the difference between the pressure in the condenser or pipe and the atmospheric pressure at the given time and

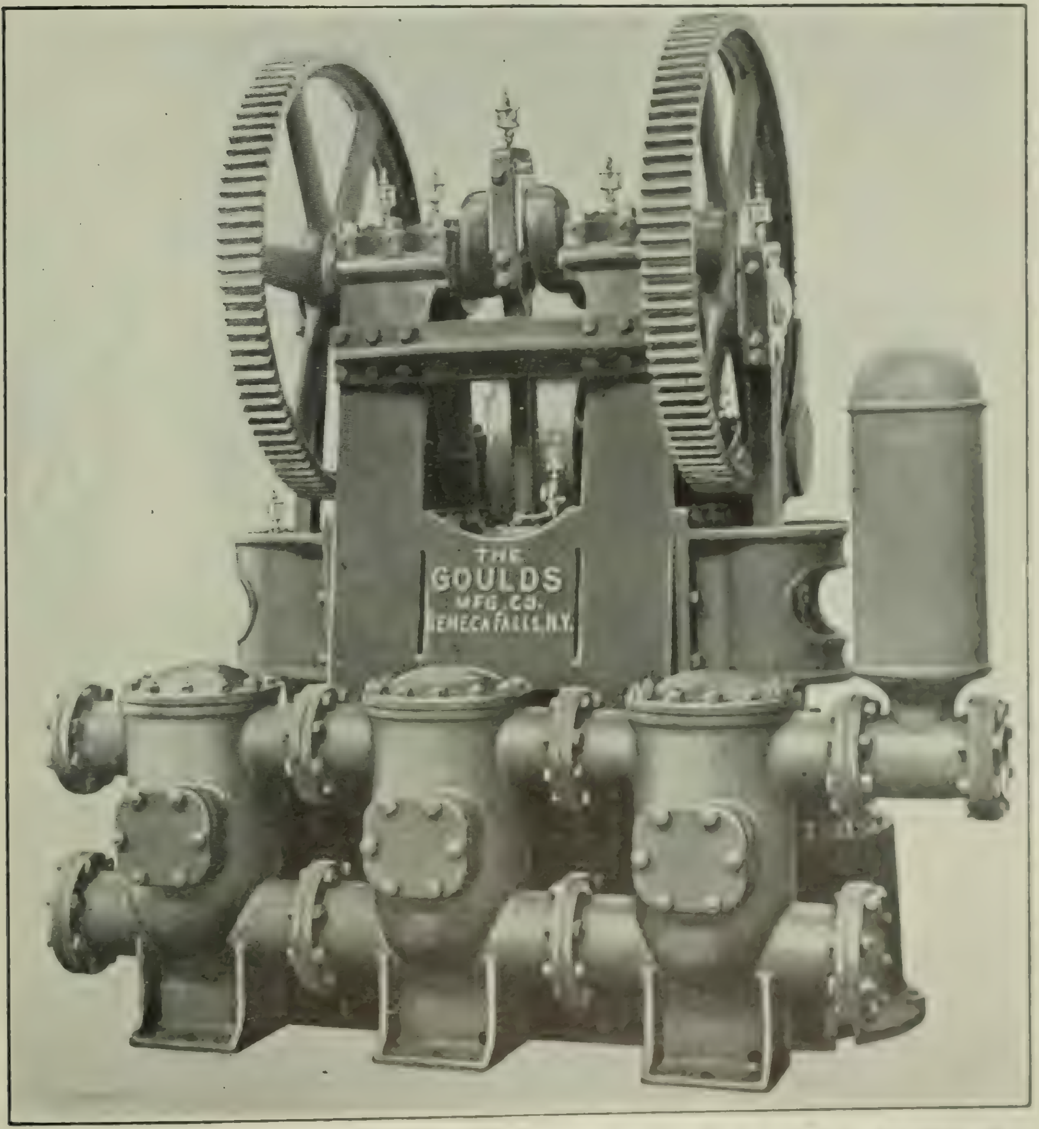


FIG. 25. A SINGLE-ACTING TRIPLEX PLUNGER PUMP FOR CONDENSER SERVICE.

To be driven by line shaft or electric motor; size [illegible] by [illegible] in. The Goulds Manufacturing Co., Seneca Falls, N. Y.

place, and we must know this atmospheric pressure before we can ascertain what is the actual pressure in the condenser or pipe in question. Moreover, when we are comparing two or more vacuums expressed as inches of mercury, even if we are given the height of the barometer in each case, if the height in the two cases is not the same, we have a calculation to make before we can get our comparison. When we are dealing with poor vacuums, the method of expressing does not much matter—that is to say, the statement “a vacuum of 20 inches of mercury” gives us a good idea of the state of affairs even if we do not know the condition of the atmosphere as indicated by the barometer. When, however, we are dealing with very good vacuums the case is very different—28 inches of mercury when the barometer is at 29 is a very different thing from 28 inches of mercury when the barometer is at 31; the pressure in the one case is three times what it is in the other. If the state of vacuum were always expressed by giving the absolute pressure, results could be compared with certainty and without any trouble and there would be the further advantage that the pressure would be expressed in the form usually tabulated along with the volume and other properties of saturated steam. For example, if the pressure in the exhaust pipe from a steam engine is given as being 1.5 pounds per square inch absolute, we at once find from a table of the properties of saturated steam that there are 1,117 British thermal units (reckoned above water at 32 degrees F.) leaving the engine for every pound of steam in the form of steam. If, on the other hand, the pressure in the exhaust pipe is expressed by giving the inches of mercury of vacuum, we have to make a conversion before we can read off the British thermal units.

METHODS FOR THE STARTING OF THE GAS ENGINE.

By Rodolphe Mathot.

IN the operation of a gas engine of the four-cycle type, there is first drawn into the cylinder the explosive mixture of gas and air which by its combustion is to develop the motive power. This charge is then compressed to a point varying from 70 to 170 pounds per square inch (5 to 12 kilogrammes per square centimetre). Next it is ignited, by a hot tube or an electric spark. As an obvious consequence, these internal-combustion motors are subject to the danger of a violent backward kick if, at the end of the compression, the gaseous mixture is exploded before the crank has passed the compression dead point. It therefore becomes indispensable, in the interest both of the avoidance of accident and of quick starting, to provide such motors either with a special device which will obviate the danger just indicated, or with an automatic starting system which will prevent the difficulty from arising.

Motors of low power—from one to twelve or fifteen horse—running on city gas or on benzine or heavier oil, are not in general fitted with any special devices. The workman in charge contents himself with turning the flywheel, either by his own effort or with the help of one or more assistants, until a proper explosion is secured, sufficient to turn the shaft at a speed which will overcome the frictional resistances and produce the necessary compression leading to the next explosion. This procedure, while primitive and tiresome, is likely to remain long in use so far as small motors are concerned.

Caution should, however, be given, in every case, not under any circumstances to attempt to move the wheel by bearing down with the foot upon its arms. Most of the accidents which have occurred in starting internal-combustion engines have arisen from this faulty and dangerous practise. The wheel should be turned only by pulling by hand upon the rim.

Motors in which the compression exceeds 80 to 100 pounds per square inch (6 to 7 kilogrammes per square centimetre) are generally provided with a so-called "relief cam." This operates by opening the escape valve for an instant, just at the period of compression, thus allowing part of the mixture to escape. The pressure is thus kept within limits which can be overcome by the hand turning of the flywheel, and the piston can be forced to the end of its stroke in the cylinder. To avoid the inconvenience of pulling on the flywheel, there have been devised systems of hand cranks operating on the crank shaft, constituting a sort of safety appliance by which is avoided all the danger arising from an unexpected back stroke of the engine.

Designers and constructors of internal-combustion engines have given considerable attention to the matter of greater convenience in starting devices, and the results are apparent in a number of systems arriving at practically the same result. Among these might be instanced an arrangement of piping, provided with cocks, by the manipulation of which a certain charge of gas, drawn from the supply main, may be introduced into the cylinder of the motor at rest. The piston is previously brought into the proper position, and behind it is formed a mixture of gas and air which ignites on contact with a naked flame supported near a suitable orifice. An explosion results, automatically closes the ignition orifice, and gives the piston the initial power stroke. The motor, thus started, continues in operation by the regular sequence of its cycles. The start in this case is made without previous compression of the first combustion charge of gas and air. Other constructors have conceived of the use of hand pumps, compressing into the cylinder a mixture of air and gas or inflammable vapor, which should then be ignited at the proper moment by turning a cock which would bring it into contact with the ignition device.

The means just described are not of the highest possible efficacy. They require on the part of the operator a certain facility of manipulation which can only be acquired with time. They have, further, the disadvantage of giving an impulsion of sudden violence to the piston, the crank shaft, and the flywheel at the moment of starting. This results in injuries from hammer blows in the journals and from torsional strain in the shaft. Further, when the motor is operating with lean gas, the method of ignition without previous compression is inapplicable and the second system described is of very uncertain action. Thus these methods have given way, by degrees, in favor of the use of compressed air.

The operation of compressed-air apparatus is far more simple and certain than that of the devices just described, and less dangerous. The principal feature of the necessary apparatus is an air reservoir of iron or steel plate, heavy enough to carry a pressure of 12 to 15 atmospheres (170 to 200 pounds). Its volume should be sufficient to provide for several successive starting charges without refilling. It is connected with the motor cylinder by a system of piping which differs in arrangement according as the air reservoir is to be filled by the motor itself, acting as a compressor, or by an independent compressor separately driven. In the former case, this pipe has a stop cock next the cylinder and a check valve admitting the air into the reservoir. By means of this arrangement, when the motor has been running and the gas is cut off, the opening of the stop cock will admit to the reservoir, with each compression stroke, the air drawn into the motor cylinder during the preceding aspirating stroke. When the motor, thus operating by flywheel inertia, begins to slow down below the point of effective working, the stop cock is closed and the gas-admission valve opened for a few revolutions, or until the motor is speeded up sufficiently to resume the charging of the compressed-air reservoir. When this is completely accomplished, all valves are tightly closed to prevent loss of air pressure by leakage.

In the case of independent compression, especially with motors of more than 50 horse power, the piping between the engine and the compressor is of necessity wholly separate from that serving for gas supply to the motor.

The reservoir being charged, the operation of starting the motor is as follows:— The relief cam is thrown into engagement, and the piston brought into the starting position, which corresponds to a point from 10 to 20 degrees in the direction of rotation, in advance of the rear dead point reached just after the period of compression. The cock of the compressed-air supply is then opened sharply, letting the air enter suddenly and quickly closed, and cutting it off when the impulse has been given, to readmit it again at the corresponding point of the next revolution. This manipulation is repeated several times, until the motor has attained a sufficient speed. Then the compressed air is finally cut off and the regular gas supply admitted.

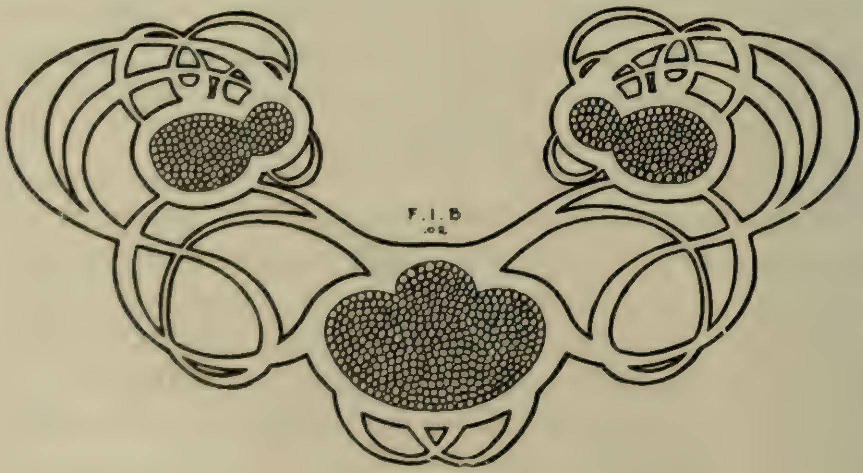
The air piping must be made perfectly tight, and the reservoirs must have a capacity in inverse ratio to the pressure they are designed to carry—that is, the lower the pressure of the supply they store, the larger they must be. For example, a reservoir normally carrying compressed air at a pressure of 100 to 120 pounds should be of at least five or six times the volume of the cylinder of the motor. If the reservoir is charged by the motor itself, the maximum pressure attainable in it is from 15 to 20 per cent lower than that of the compression of the cylinder.

Before any attempt is made to start the engine the ignition apparatus should be examined and prepared for its work. If the hot-tube system is used, the Bunsen burner, by which the tube is heated, must be lighted, the air supply to this burner being so regulated that the characteristic blue flame of complete combustion is obtained. The time required for the tube to reach the bright red heat varies with the material of which it is made; usually five to ten minutes will be found sufficient. This time may be well employed in examining the oil cups and attending to the general lubrication system of the engine.

In the case of electric ignition, this being the method usually found on large engines, its performance should be tested beforehand. If the method employed is that of a battery and induction coil, the circuit should be completed and the flow of current observed, the hum of the vibrating interrupter on the coil being an indication of its action, the circuit should be made through the contact mounted on the intermediary shaft of the engine.

When the ignition apparatus is operated by a magneto it is not generally necessary to make an inspection every time the engine is started, as there is less liability to derangement in this case. The starting of the engine itself starts the magneto, but it is advisable to retard the production of the spark at first, in order to avoid premature ignitions.

When an engine has not been running for some days it should be turned over several times before any charge is introduced, in order to see that all is in running order. The same precaution should be taken if a start has not been successful, so that any imperfect mixtures of air and gas may be removed. In all such matters a reasonable degree of judgment should be employed, without which no specific directions can be expected to serve.



PERSONAL RECOLLECTIONS OF THE DEVELOPMENT OF THE ELECTRICAL INDUSTRY.

By Prof. Elihu Thomson.

The following article was originally delivered by Professor Thomson as an address before the body of apprentices of the General Electric Company in Lincoln Hall, West Lynn, Mass. The lecture was prepared in compliance with a request by Mr. Magnus W. Alexander, who is in general charge of the apprentices. It was stenographically reported as delivered, and as now first given out in printed form has been fully and carefully revised by Professor Thomson and adapted to the wider audience reached by the pages of this Magazine. We are glad to have the particular honor of being the only medium through which Professor Thomson's most interesting reminiscences are made available to the engineering profession at large.—The Editors.

LET us, in opening what will be but a brief outline of the development of the electrical industry in Lynn, look back to the conditions about 1876. In that year the Centennial Exposition was held in Philadelphia. This was the first large exposition in the United States, and was in commemoration of the Declaration of Independence in 1776. I lived in Philadelphia at that time, and of course can speak from a very intimate knowledge of things as they were. To give you some idea of the difference between that time and this, I have simply to mention that during that exposition no buildings were kept open at night; there was no means of lighting such buildings at night with any kind of ease or safety. All the power that was distributed, nearly all the machinery the exposition possessed, was in one building—Machinery Hall—and the hall was traversed from the centre in four directions by enormous shafts, with enormous belts and pulleys driving every piece of machinery in that hall. The engine—a very large Corliss engine it was called—of 1,400 horse power, was geared by great wooden cogs to a jack shaft below, and that jack shaft, by bevel gear and belting, distributed power to the line shafting which ran the length of the building. This may give you some notion of the conditions of power supply. There was a railway running through the grounds; of course it was a steam road. Nothing else could have been thought of—nothing in the way of trolley cars; nothing in the way of electric railways.

Now, what did we find there in the way of electrical display? There were exhibits chiefly of telegraph instruments, and a small exhibit of telephones, but nobody believed that such an instrument was of any account, although it was used for the first time during the Centennial Exposition to transmit articulate speech over a line, and Lord Kelvin, who was then Sir William Thomson, was one of the witnesses called to testify to the fact that it did transmit speech. Even then it was two years before the telephone became recognized as a useful instrument of communication. Just try to imagine what the limitations were at a time when it was impossible to light a large building with any ease and without danger; perhaps with gas lights; perhaps with candles; perhaps with kerosene. I should say, however, that there were but two exhibits in that exposition which concerned electric lighting. One of these was the Gramme Electrical Company's. The Gramme machine was made in Paris and was used to furnish current to a single arc light. Another machine, the Wallace-Farmer, was used at intervals to work another single arc light. A machine to work two lights, three, four or more lights, was unknown. There was a dynamo in the Gramme space (a little space, too), which drove as a motor another machine, and this motor worked a pump and ran a little water-fall. That was the first typical exhibit of the transmission of power by electricity in the United States, I think. It was the germ of a great industry. I was very naturally interested in all this—deeply interested. I had been building small dynamos, even before that time, and had experimented in a general way with electric lighting and so on, and I was much interested in seeing even these comparatively small exhibits.

In 1878, at the Paris Exposition, one of the streets of Paris—the Place de l'Opéra and the Avenue de l'Opéra—was for the first time lighted by a system called the Jablochkoff. In this system two carbon pieces were put up parallel to each other and the electric current passed across a white insulating material between. This was kaolin. This lighting created a very great sensation. Each of the large globes contained a number of the Jablochkoff candles, as these double carbon sticks were called, because these only lasted about an hour or an hour and a quarter, and when one was burned down the next had to be switched on, and so to the last in the globe. But they made a splendid effect for those times and attracted universal attention.

I was naturally interested, and went to Paris partly to see this exhibit. I made the trip abroad at that time to get all the knowledge I could in relation to this new electric development, but came away believing the Jablochkoff candle was not the thing for lighting; that it was beautiful but expensive, and not the direction in which it was proper to work. On getting back I set about producing what was finally called the Thomson-Houston system, joining energies with Prof. Houston, who was, like myself, teaching in the Philadelphia Central High School at that time. He was professor of physics and I professor of chemistry. We produced a dynamo and lamps. My first machine, intended for running an actual electric light, was built in 1876, but was very moderate in size, and very small in the matter of light. I could, by the use of a foot lathe, get a small arc light out of it. By working very hard and perspiring a great deal I could keep the light going for about a minute or so. In 1878, however, I built a machine which was capable of giving about 120 volts and 10 amperes. I made the patterns and put the machine together absolutely without any planing, having only a foot lathe at command. The armature was made up of cast-iron discs strung on a wooden hub or shaft, yet the machine certainly worked and was shown in operation at the Franklin Institute during the winter of 1878-1879. It weighed about 350 pounds and was not only a continuous-current dynamo but would give alternating currents. One could take from one end of the shaft continuous current, or direct current, and from the other end alternating current. More than that, one could get alternating current in two-phase relation. It was, in fact, a two-phase alternating-current machine, self-exciting, and the old machine has been preserved in the model collection at the Lynn works. This machine was in reality the beginning of our actual arc-lighting work on which was founded this industry.

In 1878 this machine was shown, as I have mentioned, at the Franklin Institute. It attracted the attention of Mr. Garrett, a typical Philadelphia Quaker, who was then the agent of the Brush Company, which was just beginning to put out some few arc lights. A few machines were in use, giving two to four arc lights to the machine. I must explain here that these machines worked in this way; whenever you wanted a light you ran a separate circuit out and back to the machine. They were what we may call single-arc multi-circuit machines. One set of armature coils fed to this line, another this, and so on, and for four lights you had to have four dynamos in one. The idea of putting lights one after the other in series was not developed at that time. Mr. Garrett asked if we could get up a four-light machine that would run these single-circuit lights, and he was told that we would try. "Well," he said, "if you want to try I will bear the expense and see how you come out." So I set to work at once. Evenings and whole nights were spent in getting information together and calculating out, as best I could, what that machine should be and how to build it in a small machine shop. I would not trust anybody to do the winding but myself. I personally wound the armature and the field and did everything necessary of an electrical nature to ensure that nothing would go wrong. It must be borne in mind that no armature winders were to be had in those days. It would have taken a great deal of superintendence to get any man to wind an armature correctly, or to do anything with insulated wire where the voltage was considerable. This machine was wound and run, and it gave four lights in four separate circuits. As the machine was being completed Mr. Garrett came in one day and said "Can you not run those lights on one wire? I hear that the Brush Company is doing it." "Oh yes," I said, "I can." We soon had them running on one wire, 20 amperes to each light. They were very large and very beautiful arc lights, such as are not often seen nowadays. The lights ran all night in a bakery, and soon after a number were installed in a brewery, and so the business began. The bakery was fearfully hot in summer and the temperature was about 140° in the room where the machine was running. We had to stay in it, and so got baked as well as the bread and the arc machine. But somehow or other the machine stood up, and we stood up also. Not long after the machine had been in operation another inquiry came from Mr. Garrett:—"Can you make that machine give half as much light per lamp and twice as many lamps, or can you put on more lamps and split the current up?" I said we could, for I had thought it all out before, believing it was coming; I did not wish to push him, but waited for him to push me in that respect, but the machine was all ready so that the circuit could be divided and made into what we called an eight-light 10-ampere series arc machine. For years after that the 10-ampere arc circuit was the standard, not only for ourselves, but for the other arc-light companies, with but one or two exceptions. The above conveys a general idea of how the Thomson-Houston arc system was started.

Mr. Garrett began to build machines after the first model and to sell them. One went into a brewery. An instance of something which happened there will show the way in which those new things were regarded at the time. We had established a seven-arc-light machine in this brewery, the proprietor, a good friend of ours, being willing to stake his lighting on our success. We were able to give him what he wanted, so put in the proper machinery and lighted this brewery. One night, for some reason or other, the hay in the loft above the stable which was part of the building took fire. It was thought that somebody had been smoking there. The engineer at once shut down the lights, but the proprietor said, "No! No! Keep the lights on; I want to get the horses out." But when the firemen came, being unused to such lights, they played the hose on them and could not put them out. They were astonished to find that the globes could be full of water and that the light was still burning under water. Thus they learned that the electric light was different from other lights. There is no doubt in my mind that the fact that the electric light was kept going during the fire saved the building, because it enabled the firemen to work, and the only damage was in the upper story, in the malt room. The lights were run for a week or so afterwards with the wire lying across the burned portion of the building, so to speak. The circuit wire passed through this burned portion and still ran the lights. I mention this as an incident of the early days, when the nature of electric lighting was still little known.

It required, as you may well believe, a considerable amount of courage to start an enterprise of this kind; not knowing what market there might be for electrical apparatus. It required that we, as it were, should prejudge the future. But it seemed as if an era was opening in which electricity should have a great part—at least so it seemed to me—and shortly afterwards a company was organized to begin operations, in New Britain, Conn., and it was called the American Electric Company. It was formed for the exploitation of the system which we had been developing, and it carried on the work there for a year or two. The management was not very satisfactory at the start—was not pushing, not energetic—and the work dragged; but we kept at it and kept developing new things and perfecting our arrangements so that by the time the beginning of 1882 came there was a 25-light arc machine in existence and a number of appliances that made the system a very workable one—regulators, etc. In other words, we had, during this time of what one might call indifferent business management, thought it best to get everything in good shape so that we could make a creditable effect with our arc-lighting system, when a better business outlook presented. I may say here that our arc-lighting system was the thing we began with, and that alone—simply a dynamo, regulators and arc lights. In 1882 our lights were shown in Boston for the first time.

Just at that time it happened that two or three gentlemen of

Lynn, Mr. Henry A. Pevear, the first president of the Thomson-Houston Electric Company in Lynn, Mr. Silas A. Barton, the business manager, and a few others, were thinking of starting a little local electric-lighting company for supplying electric light to stores on Market Street and thereabout. They happened to see our lights which had been put up in Boston, and which were being run by a company that was really only a stock-jobbing affair. This company was using one of our lighting machines as its own. But the promoters did not remove the nameplate from the machine, as it happened, and Mr. Pevear and Mr. Barton saw that the American Electric Company, of New Britain, Conn., were the makers, and took a train for New Britain to find out whether apparatus of that kind could be purchased. They appeared at New Britain one day in 1882. I was there, as was also Mr. E. W. Rice, now of Schenectady, and at present one of the vice-presidents of the General Electric Company, and we received them. We told them that we did not know whether we could furnish them this apparatus or not. The majority of our stock had been bought out by the Brush Company, of Cleveland, and we did not know whether or not they might try to shut us up. "Well," they said, "can't we buy what the Brush Company have bought?" "Possibly you may," we said. To make a long story short, negotiations were begun and by the fall of the year 1882 the Lynn syndicate had purchased from the Brush Company such stock as was held by the Brush Company. At once the Lynn management set to work with great vigor to make up for lost time. I must give all praise to the energy and push of the Lynn management at that time. It came into the matter with courage and determination to make the enterprise succeed. It ran the shop in New Britain for about a year while factory "A" was being built in Lynn. As soon as this was built we were to pick up everything and leave New Britain and come to Lynn, all of which occurred in the fall of 1883. So the first appearance of this electrical industry in Lynn was in the fall of 1883.

We then had only factory "A." The lower floor we had for the heavy work, such as dynamos; the upper floor was for lamps and the middle floor for development work, pattern work, and drafting. Everything was packed into factory "A," and Mr. Pevear thought—this is a story which he laughs about nowadays—that we should not need all of this building. He said: "Well, this business may not need the whole of factory "A," but anyhow the upper floor can be used for drying skins." It was but a few months before not only did we want all the floors there were in "A," but more room. "A" was loaded down from cellar to roof with all sorts of machines packed in closely everywhere, until it became doubtful whether the floors would withstand the weight, and I remember calling Mr. Baker's attention at one time to the floor weakening in "A" on account of overload. That was later on. But in these early days that was the condition—almost a serious risk from the weight there was in that building. This soon led, in 1886, to the building of factory "B," which gave considerable relief. Then we thought we had a great deal of room. It was not very long, however, before that building filled up, too. The top floor was the incandescent lamp factory, the middle floor the pattern shop, model room and office, and the lower floor was used for dynamo testing for some time. Factory "A" was given up to manufacturing parts almost entirely. Further on factory "C" was built and that was very soon filled; we kept on, as you know, and have now got pretty well along the alphabet, to factory R.

Now, this growth was of course not all the result of our original business of arc lights; it grew out of that business, but the Lynn management felt that we could not afford to tie ourselves down to any particular kind of application of electricity. We must take business of every kind that offered in the larger application of electricity. So after the arc-lighting system was completed and in use, and so on, the next thing developed was incandescent lights, adapted to run on the arc-light circuits, to run in series with the arcs on the arc machine. Then came incandescent lights on continuous-potential circuits, as they are called. This was an entirely new business for us. It took some time to get under way—a great many things had to be done. And here I wish to say that while this was going on the Edison Company was devoting itself almost entirely to incandescent lights, and was building up a business at Schenectady—the Edison Machine Works. Later on, when the incandescent-lamp works had got well started, came alternating-current work, about 1886. Before that time everything had been direct-current. Alternating current had very slight place—and in speaking of alternating current I mean alternating currents sent over the line at high pressures with transformers to reduce the pressure for local lines. The beginning of the transformer work, which, as you know, forms a large portion of our work today, was in 1886.

But one of the greatest changes took place in 1887. This was the year of the beginning of the railway work. Nearly all of the cars before that time throughout the country were drawn by horses. The Crescent Beach line, one of the first trolley lines run by the Thomson-Houston Company, started in 1887. Very soon after that a line went over the Highlands through Lynn, the test being to see whether the trolley car could climb the heavy grades and make trips regularly without trouble. It was demonstrated to be feasible, and from that time the business of trolley-car introduction on electrical railways increased enormously.

Here I wish to say something about the spirit which existed in our organization. The management was always ready to recognize merit outside of the organization. There might be merit inside it, but the recognition of outside merit was just as ready as of that inside. It was found that Mr. Charles J. Van Depoele had been working on electrical apparatus in Chicago and had made considerable success in a way, without real financial return, and that Mr. Van Depoele was getting somewhat discouraged. We were quite ready to take Mr. Van Depoele under our wing and give him that encouragement which he needed. He had done considerable pioneer work which even at this day is found in electric railways. He was the originator of what is called "the under-running trolley"—that is, the little wheel on the pole running under the wire. There was run by him, I think in 1885, a short line in Toronto, on that plan. Before that time it had been the regular custom to run the little wheel on top of the wire—the over-running trolley, it was called—a kind of little car that used the wire as a track, with a cable led down to the car below. Sometimes the little car had two tracks, that is, an outgoing and a return wire were placed above the track and the little car rolled over these two—that was the over-running double trolley. I do not want to make these reminiscences too tedious, but I wish to say that the railway business grew far more rapidly perhaps than almost any other business undertaken. Then came along meters and other devices in endless series. We know that we have continued the same proportion of growth and development right along, and of course we hope that we shall never see the end of the extension and development, and I do not think we shall.

Later came a large development in stationary motors and the use of cast steel for motors and dynamos. Previously cast iron was the thing used in making all the frames of motors and dynamos. Cast steel could not be obtained. I remember distinctly writing to steel manufacturers around the country, asking if we could not get castings of such and such a shape of cast steel, and they said that steel could not be cast that way. Finally, we had to put up our own steel foundries.

Now, in 1891, or about that time, came a great change. The Thomson-Houston Company here had achieved a great reputation and was a very active company. The Edison Company in Schenectady was doing a large portion of the business. An interesting fact, however, is that the Thomson-Houston Company, which had formerly been in the hands of the Brush Company, as I have told you, before the Lynn people became interested in it, had bought out the whole Brush Company—had turned the tables and bought out the Brush Company and factory at Cleveland. Then shortly came the great consolidation which made the General Electric Company. "Why did such a consolidation appeal to the managers of the companies and others interested?" you may ask. Well, there was a large amount of money expended in competition with each other's business and in litigation, the outcome of which was uncertain, and so consolidation seemed the most natural thing in the world. One company was doing a large business in its own particular line, another doing a big business in the same and different lines, and it was inevitable that they should severely compete, both in the market and in the courts. Business was impossible, in the best sense, when a great deal of money and talent which ought to go into dividends was being expended in legal combats or used in destructive warfare in the commercial market. Under these conditions the companies came together and the union of interests was perfected.

Mr. C. A. Coffin, now the president of the General Electric Company, had been active in the management from the start at Lynn, and was at the head of the Thomson-Houston Company at the time of the consolidation. It is not too much to say that to his energy and resourcefulness much of the successful building up of the enterprise was due.

Now, what have we to look for in the future? Is this great growth that I have outlined—in the briefest possible way, I must confess—going to go on? I think so. But what I wish to impress upon the young men in the electrical profession is that as you grow up you will find no really good result is ever obtained unless you are willing to exert yourself for it. In our early days we had lots of trouble, hard fights and plenty of difficulties to overcome in establishing this industry. Sometimes it has been hard to overcome obstacles or even prejudices against new things. Trolley lines were not adopted without such struggles. I recall being cross-questioned in no very gentle way because I favored the introduction of the trolley line for Boston, as to whether people would not be killed or this disaster or that or the other calamity follow. I am happy to say that I was able to answer most of such inquiries and to satisfy those in control that there was not going to be any disaster following the introduction of the electric railway in the streets. In the early days, in 1882, as I have told you, we were bought out by the Brush Company. That was a time of discouragement. We did not know whether we were going to be shut up or to go on with the business. But, fortunately, owing to the little accident of the Lynn people seeing what we were doing, the scale was at last turned and we began operations afresh with renewed courage, and of course with eventual success. It is indeed something to belong to; to be connected with, an organization which has in so short a time grown to the magnitude and importance of our electrical industry.

When the consolidation came, the top floor of "B" was used for the manufacture of incandescent lights, but afterwards the whole of this work went to the Edison lamp works at Harrison, N. J. But our men went there, too, and they introduced the methods which had been pursued here, with the result that the incandescent lamp was much improved in a short time. You can see the benefit of bringing the two organizations together. The methods applied in two separate works have been combined and work of a higher standard than either could have reached in a short time separately has been the result. The incandescent lamp of today is enormously better than the best made in those early days. This is the result of the union of effort, and it is to union of effort in many lines that we have to look for advancement in the future.

EDITORIAL COMMENT

THERE is a very general disposition to suspend the interpretation of Japan's overwhelming naval victory until much fuller data are available than have yet been received from the Far East. Judging by the precedent set and rigorously maintained by Japan since the beginning of hostilities, we may not expect a very ready willingness to give out the details of Togo's tactics leading up to the battle, and for the present must rest as content as possible with his ascription of the results to the resplendent virtues of the Mikado. The deduction from analogy is that the Russians were defeated by the vices of the Czar.

And after all, this flower of Oriental expression has a root of solid fact. The one thing which is perfectly clear even now, and which is more fundamental than any point of strategy or tactics, is that the Japanese victory was the logical result of a super excellent order of honesty and devotion in the nation of which the Mikado is the formal head, while the Russian rout is the equally logical end of national dishonesty, official corruption, and "graft" run rampant. Rojestvensky was defeated before he sailed from the Baltic, by the rottenness bred in the Russian court and spread through almost every institution of the country, sapping its physical strength and destroying its moral fibre. Russia, once the giant of the nations, has been exhausted to the point of collapse by systematic, unchecked dishonesty in high places.

* * *

THERE is a grave suggestion in this which we may take home, for we too as a nation are cursed with graft. Corruption, favoritism, incompetency, are regarded as quite normal in the political administration of our public affairs, and almost no one attempts to "do anything about it." Finance is nearly —and "high finance" is quite—synonymous with trickery, and the world shrugs its shoulders at the disclosures. The managers of one of the greatest of our fiduciary institutions are discovered in transactions of a kind for which their butler or coachman would be dismissed in disgrace, and their course is aggressively and indignantly defended on the ground of custom and precedent. It is hard to say whether the indifferent pessimism too often shown by the public is not a worse danger than the evil of dishonesty itself. But fortunately the public conscience is not dead, and the public indignation not at all beyond awakening. Philadelphia and the Equitable Life scandal have shown that honesty, of the kind dubbed "old-fashioned" by party bosses and modern financiers, still lives in the masses; and when aroused it is powerful enough to sweep bosses and financiers, however loudly protesting, from their grasp of power and into acceptance of its dictates. To this recovery Russia also will come, but by steps it may be fearful to contemplate. In the freedom with which public opinion is expressed, and in the power which it exercises without violence, lie our National safety. The conservation of that safety depends upon the assertion and the exercise of the National conscience before the conduct of any class has become fatally separated from the sound standards of morality of the masses.

There has been recently expressed some degree of anxiety in various quarters as to the probable durability of the modern tall building, and numerous alarmist statements have appeared from time to time in the sensational press representing the skeleton-steel structure as trembling to decay before the invisible actions of corrosion, vibration, and general molecular degradation. The absurdity of these forebodings will be realized when it is appreciated that the demands upon the steel structure are far within its capabilities of resistance. So far as vibration is concerned, there is not a steel ship afloat which is not subjected to buffetings before which the slight tremblings of the tall building are microscopic; and the modern ocean liner is twice the length of the tallest building in existence, the Eiffel tower alone excepted. No one fears the failure of the metal in the steamship, because every one realizes that long before any appreciable deterioration can occur the great liner will have been relegated to the junk yard and the scrap heap, superseded by a swifter vessel, of a newer model, and greater capacity. The tall building is in a similar position. There now stands, in the city of New York, a modest structure of eleven stories in height called, since the time of its construction in 1888, the Tower Building, because it rose at that time like a tall watch tower above the smaller houses in lower Broadway. This was the first of the modern tall buildings in which the weights were carried upon a structural skeleton, instead of requiring heavy walls of masonry to bear the burden and transmit it to a limited foundation area. Today the Tower Building is lost amid the far greater structures between which it is sandwiched, and having outlived its usefulness, it is to be torn down to make way for a new structure of more than double the height.

We have thus the interesting fact that the first tall building, regarded in its day as a marvel of engineering audacity, has lived its life in the short space of seventeen years, not because it is worn out, or unsafe, or in any way objectionable, but simply because it cumbereth the ground, so to speak, because it is not tall enough, because it has outlived its usefulness! The buildings of past ages which have remained are extremely few, and with the exception of a small number of monumental structures, the most massive erections of masonry have given place to newer buildings, better adapted to the requirements of their surroundings. The modern tall building is no exception; it will fill its place in the passing conditions of life, commerce, and industry, and make way in its turn to something developed by the constantly changing environment.

* * *

We referred in the last issue of the Magazine to the question of high-speed railway trains, and almost before the ink was dry upon the page came reports of still swifter trains, reducing the time between New York and Chicago from twenty hours to eighteen, and even to sixteen hours! There appears to be little doubt that the question of railway speeds depends more upon the condition of the road-bed than upon the locomotives, and given a clear track and a sufficiently substantial superstructure, there appears to be no good reason why the speeds made upon the military railway between Marienfelde and Zossen should not be repeated in daily service. The whole matter is a commercial question—a question of a sufficient number of passengers.

At the same time it must not be forgotten that more time is wasted at the terminals every day, with every train, than is gained by these forced speeds upon the road, and it is at the ends of the line, and not in the middle, that the most time is to be saved.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

INDUSTRIAL ENGINEERING.

THE WORK OF THE MODERN ENGINEER CONSIDERED AS AN ECONOMIST AND INDUSTRIAL ADMINISTRATOR.

Henry R. Towne—Purdue University.

THE early conception of the engineer was that of a man who planned things, mechanical and otherwise, and also attended to their construction and operation, and it is only within recent years that he has been supposed to have anything to do with the commercial side of the works which he has so largely created. Now, however, the scope of engineering work has been immeasurely broadened by reason of its development to include the control of administration, and in this way the engineer has come to realize that he must also be a man of business and affairs, and that his work must be well done, not only from a technical viewpoint, but also from the position of commercial success.

In an address recently delivered before the faculty and students of Purdue University, Mr. Henry R. Towne, himself well known as an engineer and as a successful business man, this important subject of industrial engineering is brought out in a very effective manner.

Mr. Towne clearly states than the question of cost must be taken as the controlling one in nearly every instance:

"The *dollar* is the final term in almost every equation which arises in the practice of engineering in any or all of its branches, except qualifiedly as to military and naval engineering, where in some cases cost may be ignored. In other words, the true function of the engineer is, or should be, not only to determine how physical problems may be solved, but also how they may be solved most economically. For example, a railroad may have to be carried over a gorge or valley. Obviously it does not need an engineer to point out that this may be done by filling the chasm with earth, but only a bridge engineer is competent to determine whether it is cheaper to do this or to bridge it, and to design the bridge which will safely and most cheaply serve, the cost of which should be compared with that of an earth fill. Therefore, the engineer is by the nature of his vocation, an economist. His function is not only to design, but also so to design as to ensure the best economical result. He who designs an unsafe structure or an inoperative machine is a bad engineer; he who designs them so that they are safe and operative, but needlessly expensive, is a poor engineer, and, it may be remarked, usually earns poor pay; he who designs good work, which can be executed at fair cost, is a sound and usually a successful engineer; he who does the best work at lowest cost sooner or later stands at the top of his profession, and usually has the reward which this implies."

At the present time nearly all the engineers who have attained success in the art of combining the scientific and commercial departments of work have acquired their knowledge in the hard school of experionce. The technical schools teach the science of engineering in a thorough and effective manner, but they turn their students out into the world of practice with little or no knowledge of that most important side of their profession, the industrial department. Mr. Towne emphasises this point, and refers to the absence of text books and literature adapted for instruction in this important department of education. It is encouraging to see that this matter is receiving attention, and in various quarters there has appeared of late a demand that portion of the training of the engineering student should include the elements of such things as cost keeping, expence accounts, the influence of depreciation, of scrapping upon design, etc. These, and all the related details of industrial engineering should form as much a portion of the equipment of the trained student as a knowledge of the strength of materials, the principle of mechanics, the laws of thermodynamics, or the science of electricity.

"Industrial engineering is the practice of one or more branches of engineering in connection with some organized establishment of a productive character, in which are conducted the operations required in the production of some articles, or series of articles, of commerce or consumption. Nearly all industrial work of this kind, especially if it be conducted on a lrge scale, involves technical, physical, and engineering questions, varying with the kind of industry but usually of wide scope. For instance, in steam engine building, it is primarily a question of thermo-dymamics and steam engineering, but it involves equally the question of the selection and right use of machines, tools, and methods of production. So likewise in electrical work, the textile industries, and all the range of our manifold industries. On its technical side each has its special and distinctive features; but on its administrative side each involves certain fundamental elements which are common to all. The technical work may be in charge of a technical man, responsible for that work only. The administrative work may be in charge of another man, not fortunate enough to have had a technical training, but a good administrator. If these two work in harmony a good result should follow. But a better result in every way will be reached where these two functions are combined in one person; where one master mind knows both the technical side of the work and how to select and direct the men who shall attend to its details, and who also has the ability and the training needed to qualify him to direct and control the work of administration. The union of these two functions in the one individual constitutes the best kind of material with which to fill leading positions, the kind of material the captains of industry are always looking for."

The pages of this magazine for the past ten years show the interest which has been taken by professional and practical men in the vital question of the relation of engineering to cost keeping and industrial accounting, and Mr. Towne lays especial stress upon this feature of modern administrative engineering.

"One of the essential elements in industrial management and enginering is industrial accounting. It is a common mistake to look upon the accountant in an industrial organization as of little importance, and his work as simply requiring ordinary intelligence, with little or no special training. Even if true as to routine commercial accounting, which usually deals only with the keeping of salesbooks, journals and ledgers. this view is radically erroneous as to industrial accounting, the ultimate purpose of which is to determine correctly the cost of products, and to furnish information which will guide the management definitely and reliably in determining where economies should be sought and how to obtain them. Taken in this sense industrial accounting is a science, and a somewhat complex one—a science which has enlisted in recent years the time and thought of brilliant and able men, who have brought it to a high stage of development and whose work to some extent is accessible for the guidance of others. Unfortunately, this broad field of work, although already highly developed and possessing a vast fund of accumulated experience, is as yet almost without any literature or other available record of its achievements, so that the work of industrial accounting which is required in each industry must be planned, devised and directed by those responsible for it without their being able to avail themselves largely of the similar, and even closely identical, work which may previously have been done by others. No one is competent to do the best work in industrial accounting, especially in planning an organizing it, who has not at least a fair knowledge and understanding of the technical facts relating to the product concerned and the methods of its production."

In the aim to attain success as an administrator the ambitious engineer may make the mistake of minimizing the importance of attention to details, while the opposite extreme, a devotion of too much time to minutiæ, is also to be avoided.

"The industrial engineer should know every detail of his work. The criticism is sometimes made of a man that he is immersed too much in details, and unfortunately the criticism is often justified. If so justified, however, it is because the man, having a knowledge of the importance of detail, has not also a proper sense of proportion and an equal appreciation of the importance of letting go of detail at the right time. Grasp detail first; shed it afterwards. Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it. Through all your work, and especially if you are called to executive positions, stand squarely for what is right; for integrity, straightforwardness, and honest dealing. You will find temptations enough to do otherwise in any walk of life. Resist them, and you will have not only the satisfaction of doing right but will find also that this pays best. The man who is honest, upright, and straightforward commands the confidence of his employers and wins the respect of his assistants and subordinates. He will lose both in the end if he travels on the other path."

MODEL EXPERIMENTS ON THE LINES OF SHIPS.

TANK EXPERIMENTS ON HOLLOW AND STRAIGHT LINES FOR SHIPS IN SMOOTH AND ROUGH WATER.

R. E. Froude—Institution of Naval Architects.

THE utility of tank experiments in the determination of form and resistance of ships is now so generally accepted that any advances made in the method are of much interest, especially when coming from one so closely identified with the system as Mr. R. E. Froude. The work of the testing tank at Haslar has been of such value in the past that experimental researches there conducted may be accepted as possessing the confidence due to long experience. In a paper presented by Mr. Froude at the recent meeting of the Institution of Naval Architects, some recent experiments are described, these bearing upon the comparative results obtained with models in smooth water and in water in which a wave motion is maintained. Tank experiments are generally conducted in smooth water, although this condition rarely, if ever, exists in actual practice, and experiments to determine the influence of waves, both upon the form of the hull and upon the powering, should be of much practical value. A vessel cannot make the same speed in a rough sea that can be made in smooth water, and it is entirely possible that a form of hull indicated by smooth-water trials may not be the best in the presence of waves.

The wave making apparatus fitted to the tank at Haslar consists of a vertical rocking diaphragm, hinged below the water level at one end of the tank, transversely to the line of the waterway, and oscillated to a uniform stroke and uniform period by a crank motion driven from the workshop shafting. There is a sloping beach at the end of the tank behind the vibrating diaphragm, and upon this incline the waves produced at the rear are received and broken, while the forward waves run the whole length of the waterway, with crest lines square to it. There is thus formed a wave system or swell of a very regular character, against which the model can be towed. The height of waves may be varied by adjusting the radius of the crank, and by means of a specially devised measurer the period and height of waves in any trial may be closely measured for the record.

"The question of the most advantageous general system or programme of experimenting with models in artificial waves turns on the circumstance (which was to be anticipated from theory, but also appeared very plainly from the first preliminary experiments) that for any given speed of model the augment of resistance due to waves, as well as the behaviour generally, is very sensitive to the period of the wave system. Hence, to obtain a properly instructive measure of the relative qualities of the several forms to be tested, the experiments with each form at each speed must extend over a considerable range of wave period. Accordingly, if we confine ourselves for the moment to considering a single form at a single speed, the programme dictated by these considerations shapes itself as a series of experiments at a series of different periods extending by sufficiently close gradations throughout the range of period within which the resistance augment by waves is important in amount. And each such series needs to be repeated, more or less completely, with as many different crank radii of wave-maker as may prove necessary. Such a large number of experiments being requisite for one speed, it was, of course, out of the question to take many speeds, so as to obtain experimentally for rough water a counterpart of the usual curve of resistance in smooth water. As a fact, in the wave experiments, no more than two different speeds were taken with any model, while the most complete and systematic of the series of experiments made was confined to one speed, three knots less than the intended smooth-water full speed for ship.

"It has been found at various times that models of the size used in these experiments in waves are subject to material resistance variations from time to time, due presumably to slight differences in condition of the surface. Several smooth-water runs were therefore made with each model in connection with each series of experiments in waves, and the resistance so obtained was deducted from that in waves to give the resistance augment due to waves. The final results for the ship are obtained by adding the corresponding effective horse-power augment for the ship to the smooth water effective horse-power determined in the ordinary way from the smooth-water experiments with the models of ordinary size."

Experiments were made upon five forms of hull, the first corresponding to a cruiser form of the usual modern type, while the second and third had the hollow in the fore body and in the after body filled up perfectly straight. The two other models were designed especially for the comparison of hollow and straight lines on even terms.

Naturally the resistance of the straight line models was greater than that of the hull with the hollow lines, a higher powering thus being demanded, but at the same time there was an increase in displacement, permitting the addition of the weight of increased engine power, besides leaving a substantial margin in excess. Thus, for a vessel with hollow lines, there was a displacement of 13,050 tons, which, in the straight line form, was increased to 13,944 tons, a gain of 900 tons, while for the increase in resistance, at a speed of 23 knots the corresponding powers required were 12,000 and 14,000 horse power, a difference of 2,000 horse power, estimated as involving 300 to 400 tons additional weight, the balance being clear gain.

The resistance caused by the action of the waves was practically the same for both models, and this increased resistance was very marked, being in some instances nearly twice as great as the resistance in smooth water, depending upon the magnitude and period of the waves. At the same time the straight-line form appeared to suffer measurably less than the hollow.

The general impression among seamen appears to be in favor of the straight-line model as possessing greater stability, and less speed impairment in rough water than is shown by the hollow-line hulls. The tests with the regular and uniform waves in the tank can hardly be considered as conclusive in comparison with the mixed wave disturbances met at sea, but such trials are certainly of a more practical nature than those made in smooth water. So far as the question of powering is concerned, some information may be obtained as to the necessity of providing increased power to maintain speed in rough weather. It has been maintained that better results would be obtained by providing a slight increase in beam, sufficient to give the same increase in displacement as is gained by the straight lines, while retaining the hollow-line model, but this appears to be in a manner an evasion of the question, leading simply to a comparison between two different sizes of the same model, without regard to difference in form.

The idea of adding a wave-making attachment to a testing tank for the purpose of studying the behaviour of models under conditions approximating more closely those obtaining at sea, is wholly to be commended, and it is to be hoped that hereafter all important trials will be made both in smooth water and against wave action, as in this only can a sufficient stock of data be obtained to enable reliable conclusions to be drawn.

HIGH-POWER LOCOMOTIVES.

PRACTICAL EXPERIENCE IN THE DESIGN AND OPERATION OF AMERICAN LOCOMOTIVES OF GREAT POWER.

J. E. Muhlfeld—International Railway Congress.

AMONG the subjects discussed at the international railway congress at Washington, one of the most important was that of locomotives and rolling stock, and from this department of the work of the congress we take the report of Mr. J. E. Muhlfeld, upon locomotives of great power as containing many points of interest.

"An American locomotive of great power may be described in a few words as one capable of developing, when properly designed for the speed requirements of passenger and suburban service, at least 20,000 pounds in the cylinders at starting, with provision in suburban service for rapid acceleration and for freight, helper and switching service, at least 40,000 pounds.

"Locomotives are now expected to perform equally well work of the most varied and exacting nature, and the requirements in the way of faster schedules and heavier trains in passenger and freight service have, in connection with lack of substantial maintenance, exceeded the development of the increased power in the machine. Speed limits and train loads are increasing each day and will no doubt continue to do so, as the maximum expansion of car equipment and the length of trains under favorable conditions, have not yet been reached.

"How well the demand can be met in one steam locomotive of the present gage and clearance limits by simplicity in design, flexibility, maximum proportion of adhesive to total weight, good material and construction, pure heated feed water and quickened circulation, compounding, superheating, substantial maintenance, intelligent operation, and other essentials, is a question that must be determined in the very near future; and from this determination will proceed the conclusion as to the proper proportions of each type of locomotive required in the motive power stock for a large, modern railway system.

"Railroads are not operated to save fuel, or to have locomotives that it does not cost much to maintain and run, and while economy must be considered as secondary to getting trains over the road, at the same time, the tractive power required and the limits given within which to acquire this, make it necessary that locomotives be now so constructed and maintained that more work will be derived per unit of fuel; and the result should be economy. Whether the economy will be derived through the use of turbine, internal combustion, pneumatic or electric locomotives, or by a practical development of the steam locomotive from the use of improved boiler, motion gear, superheating, compounding, balancing and other essential features, remains to be determined."

In discussing the requirements of the modern high-power locomotive Mr. Muhlfeld takes up the various parts in succession, and enumerates at length the essentials, as developed by practical experience. We have space here for no more than a close condensation of these points, and can do little more than furnish a guide to the detailed information contained in the original extensive paper.

The boiler must be designed to supply

steam, not only for motive power, but for a host of auxiliaries, and it should be simple in design, using a large factor of safety and a great excess of strength over any legitimate stress. The principal features covered by the detailed specifications for the boiler are those providing for active circulation of the water, freedom from expansion and contraction stresses, and access for cleaning a repair. The proportions of heating and grate surface are determined by the service, pressures of 200 to 250 pounds being considered, all these requirements demanding the best of material and the very highest grade of workmanship.

An important element in boiler performance is the purity of the feed water and the method by which it is introduced. The water for heavy boilers in heavy service should be purified, and it should also be heated, either from the exhaust steam or by the exhaust gases. Apart from the economy effected by heating the feed the strains on the boiler are minimized, and much of the injury due to temperature differences prevented. Superheating is distinctly recommended, both for simple and for compound engines.

The high powering of locomotives is responsible for a marked increase in stresses on cylinders, pistons, and frames, especially in the case of engines of moderate speed, where the increase in power is due to larger cylinders and higher pressures. The heavier parts produce increased inertia stresses, and the frames should be well stayed and braced to the cylinders, boiler and each other. For the same reasons increased dimensions should be given to the pistons, and in general the actual stresses on the working parts should be considered rather than empirical proportions deduced from conditions of lighter service.

The increased dimensions required for the link motion and valve gear parts, as well as the desirability of placing the valve motion outside of the frames is causing attention to be given to the Walschaert motion. This motion, which on the Continent has become almost the only one employed, has many advantages, and there is every probability that it will come into as general use in America as in Europe. Its advantages were pointed out many years ago by Auchincloss, but until recently it has been almost entirely ignored in the United States.

Mr. Muhlfeld accepts the fact that compound locomotives are to be advocated when the cost of fuel is high and the gradient conditions favorable, but when fuel is cheap he considers the single-expansion type the most economical, providing sufficient steaming capacity can be obtained from the permissible weight of the locomotive.

Locomotives of great tractive power are not generally wrong in principle, but their growth has been too rapid for strict adherence to practice applicable to lighter equipment, and in the future development full advantage should be taken of past and present experience by giving more thorough and practical attention to all details entering into the new construction.

The general conclusions of the report may be taken as expressing the present state of practice with regard to high-powered locomotives, and as given below they form an excellent summary of an important paper.

"Locomotives of great power, within the present gauge, clearance and weight limits, may be designed and constructed to remain modern for several years and produce a higher average speed and tractive power with less cost for locomotive expenses per unit of power developed, than that given by locomotives of large capacity in use to-day or from the previous lighter equipment.

"The efficiency and economy predicted and anticipated from the use of locomotives of great power have not been attained. Their development has been too rapid on the basis of the theoretical calculations which did not include the necessary factors for practical results, and also owing to the disregard of simplicity in design, substantial maintenance and speed as elements of economy.

"Locomotives of comparatively recent construction have been built without proper consideration for the use of railroad standard designs, specifications, practices and processes which continued and practical experience may have determined to be more suitable and interchangeable than the standards of locomotive builders.

"The present ineffective load should be reduced by the use of design and material which will combine the least weight and greatest desired strength.

"The elimination of those individual preferences, patented devices, fads and frills which have no real value, by the use of simple, practical design and construction, will produce more satisfactory general results.

"The mechanical department supervision has often been curtailed when expansion of organization and direct, mechanical control should have been given to insure the desired performance. Changes in organization and methods have frequently been effected in preference to conservative management, with instruction, education and substantial recognition for the deserving rank and file.

"The locomotive maintenance and dispatch facilities have not always been developed to meet the proportionate increase in the locomotive dimensions, capacity and requirements, while slow line movement has made it necessary to increase average mileage by reducing terminal mechanical delay during a period when more opportunity for maintenance and handling has been essential.

"The tonnage hauled per train has frequently precluded the making of an average speed between initial and destination terminals that would be productive of efficiency and economy in locomotive operation.

"Decreased efficiency has resulted from the irregular transferring and crewing of locomotives for long runs. The regular assignment of crews to locomotives and of suitable locomotives to shorter runs on regular districts, should accomplish the best results.

"Provision for the cleanliness and care of employees and equipment on the line and at terminals, should receive more consideration.

"Personal supervision and investigation should govern in the construction and operation of locomotives of great power, whilst statistical information and correspondence should be limited and used with caution."

FACTORS OF SAFETY.

THE INFLUENCE OF MARGINS AND FACTORS OF SAFETY UPON THE DESIGN AND PROPORTIONS OF MACHINERY.

A. E. Seaton—Institution of Naval Architects.

IF it were possible to obtain full and complete knowledge of the resistances of materials of construction, and also to discover the nature and magnitude of all the stresses imposed upon the various members of a given structure the problems of proportion and distribution of material might be made with a precision which would leave nothing to be desired. As a matter of fact the engineer has to deal with materials of varying strengths, concerning which his information is necessarily limited, and at the same time his knowledge of the stresses, working and accidental, is far from being complete. Under these circumstances it is necessary to supplement the dimensions obtained by computation by a margin, giving an excess of material to provide for the unforeseen forces to which his work may be subjected. This margin, commonly known by the title "factor of safety" has also been termed the "factor of ignorance," not as implying a lack of knowledge, but as providing for the unexpected, which usually happens.

Among the papers presented at the recent meeting of the Institution of Naval Architects was one by the well-known marine engineer Mr. A. E. Seaton, dealing with this subject of margins and factors of safety, and showing how such factors should be rationally used. Mr. Seaton discusses principally the design of marine machinery, but the principles and methods are applicable equally well to machine design in general.

"Every structure and machine must be so designed that, when properly constructed, it is capable of safely carrying the load or developing the power for which it was intended for a considerable period; some, in fact, must do so for an indefinitely long time. At the same time, such structures and machines are, as a rule, for good and sufficient reasons, not made stronger or heavier than necessary.

"In recent years, in fact, a demand has arisen for something that shall be as light as possible consistent with the necessary strength; in such cases, however, endurance is not generally of prime or even great consequence. Notwithstanding this, every designer of such things, as, indeed, every business man, likes to have a margin on which to 'come and go,' as well as one which shall not be trenched on under normal conditions. Most rules and formulæ contain, either latent or apparent, some provision for such margins and one hears, both in the lecture theatre and drawing office, much talk of 'margins of safety' and 'factors of safety;' but it is doubtful if these things are as clearly appreciated there, or elsewhere, as is desirable in their full meaning and effects.

"One has only to read an ordinary specification of a ship or engine to perceive how nebulous appears to be the knowledge of their authors of the dangers for which factors and margins of safety are supposed to be the insurance; it will also appear that the cure for these ills, whose cause is so often not understood fully, are applied as promiscuously and with the same faith as are patent medicines for bodily ailments. Further, some of them, too, have the old analogy, in their effects, to certain drugs, inasmuch as they produce the disease they are supposed to cure.

"The component parts of structures and machines are subject to be stressed in either one or more of the following ways—viz:—

"1. By a steady and constant pull, so that the metal is in tension, or by a steady and constant pressure, so that the metal is in compression.

"2. By a pull or pressure repeatedly but gently applied and removed, so as to vary in intensity from 0 to a maximum, and the reverse.

"3. By the repeated sudden application of the full load, and its sudden removal at intervals, so that the material is suddenly and intermittently subject to tension or compression.

"4. By the repeated gradual application, gradual withdrawal and reversal of the load, so that the material is alternately in tension and compresion.

"5. By the repeated sudden application and reversal of the load, so that the material is alternately in tension and compression, the changes being sudden and violent from plus to minus."

A mere examination of the variety of stresses enumerated above will show that the margin of safety need not be the same for all of them. A member under constant and steady tension or compression does not require so great a safety factor as one subjected to sudden and varying stresses, and the real occasion of a factor of safety in such a case is to make provision for variations in the strength of the material.

"It is admitted that no metal under load should be stressed beyond its elastic limit or yield-point; it used to be considered that, if the load never stressed it to the limit of elasticity, the metal could not give way, and should last for ever. We know now that, under certain circumstances, metals will give way when apparently stressed much below that point; but we also know that to bring on destruction in that way the load must be intermittent; further, we know that if the stress is an alternating one, its magnitude, to produce fracture, may be still less than if intermittent.

"Modern research, especially that of Professor Arnold, has shown that time also enters very largely into the account when dealing with dynamic forces; that the quicker the application of the load the fewer are the repetitions necessary to ensure fracture; or, the oftener per minute are the repetitions of load, the smaller that load need be to produce fracture. Now, although we know, and have known, most of these things for many years, do we always act upon this knowledge when determining the so-called margins of safety? Are engineers always consistent in fixing the magnitude of such allowances as they make? Let us see what are really the dangers for which provision has to be made. The wrought materials used nowadays can generally be got out of fairly uniform quality, and we have the means in the tensile and drop-testing machines of ascertaining that quality, and their general suitability for the purpose for which they are wanted. Any danger due to faulty material should therefore be slight, and little or no margin is required for insurance.

"The formulæ and rules on which a design is evolved may be, and sometimes are, subject to doubt; for example, those used for giving the stress on a shaft due to torsion really only give the shear on the outer envelope, or skin, of the shaft, and without allowing for the fact that that skin is firmly attached to, and therefore supported by, the next layer of metal.

"Such also is the case when calculating the stress on a beam subject to cross-bending. But in the case of a rod suspending a weight, or in that of a short stanchion supporting a load, there can be no scepticism.

"With the shaft subject to torsion, it is difficult to determine what is the greatest nominal stress that may be put on the outer layer, so that the shaft may run in safety indefinitely. It must, of course, be such that at any point it is really below the yield-point; but how much can only be determined positively by experiment. If the shaft is subject to a steady torque, or one whose torsional variations are slight, probably the nominal stress may safely be as high as 75 per cent. of the yield-point while, if the variations are great and violent, it might not be safe with only 40 per cent. Again, if the shaft has on it a fly-wheel or a screw propeller, so that there are rapidly changing alternating stresses due to the bending moment as well as shearing forces due to torsion, perhaps 30 per cent. would not be too little to reckon on."

Mr. Seaton refers to the anomalies in the requirements of the British Board of Trade, citing as examples the fact that bridges, subjected to sudden intermittent loads, are permitted a lower factor of safety than marine boilers, in which the load is gradually applied and maintained with uniformity for long periods; also the fact that a lower margin is required for locomotive boilers than for marine boilers.

The insistence of too high a factor of safety is a mistake which may work distinct disadvantages, and the proper and scientific method is to make the margin proportional to the nature of the stresses, giving the greater proportion to structures and members exposed to sudden and irregular action, and thus avoiding excessive weights and maintaining a proper balance of strength in all parts of the structure.

"In order that a steamship may have a margin of safety to ensure her doing the intended voyage at the scheduled speed, most shipowners insist on having the trial-trip speed considerably in excess of it; the builders accept these conditions, and, knowing they are legally liable for heavy penalties for non-performance of the speed, even when no penalty is named, usually design the ship and provide engines and boilers for a still higher speed, so that they may have in their turn a margin of safety.

"Hence it comes to pass that a ship whose service speed is to be 17½ knots not uncommonly does 19½ knots on trial under service conditions, and that not on a series of runs on the measured mile, but on a long course, often of 100 miles. The effect of this kind of margin is most serious both on the design of the machinery and the ship. The latter must be formed with finer lines than there is really occasion for, with a corresponding loss of displacement; the machinery is much heavier and bulkier than necessary, thereby taking away from the carrying capacity, and often also from passenger space as well. The engine cylinders have such clearances as to reduce the steam efficiency at the service speeds; and the screws necessary for the high trial speed are not of the best proportions for the service speeds.

"I think that neither shipowners nor builders always fully realise the evils and cost of this pernicious way of insuring satisfactory performance. If the speed on service is to be 17½ knots, why not design the ship for it? If it be urged that, to make up time lost by fogs or bad weather there must be a reserve of some kind, this can be done by increasing the power and obtaining the higher speed with a slight decrease in the efficiency. It is surely better to have the lower efficiency during these occasional times than during normal conditions."

It will be seen that when the factor of safety is considered in a rational manner, as indicated by Mr. Seaton, it is no longer a factor of ignorance, but a scientific provision for emergencies, which, if not within the range of precise computation, may at least be provided for in some sort of fair proportion.

ENGINEERING LABORATORY METHODS.

THE FUNCTION OF LABORATORY INSTRUCTION IN THE CURRICULUM OF THE ENGINEERING SCHOOL.

Dr. Charles E. Lucke—American Society of Mechanical Engineers.

AMONG the papers presented at the recent convention of the American Society of Mechanical Engineers that of Dr. Charles E. Lucke upon the use of the engineering laboratory brought out an interested discussion from engineers engaged in the problems of technical education. It was the general opinion of eminent educators who visited the United States during the past year that many of the mechanical laboratories were remarkably complete and well equipped, but the opinion was also expressed that many of these fine work rooms suffered from an over-provision of appliances and an under-provision of teachers and well prepared students. Dr. Lucke takes up these and similar criticisms, discussing the various methods by which the mechanical laboratory may be employed.

"The object of all professional engineering schools is to send away thinking men with the equipment to become good engineers. A good engineer is a man who can do things in a certain field of labor rather than a man who knows a large number of facts in that same field, but is unable to use them. The technical school *can* teach students facts, and *may* train men to do and to think, but may fail utterly to do so. Much depends on the student's physical endowment, more depends on the methods of instruction, but most on the characteristics of the instructor and his individuality. This applies to such parts of the course of instruction as are dependent on the laboratory apparatus. If, by the use of apparatus, the student can acquire more than without it well and good, but the use of that apparatus will be better justified if, in addition, the student can be made to think more clearly, more boldly, more originally than without it, and finally when through the use of that apparatus he can be taught to do things, then not only is the use of apparatus justified, but it must be regarded as indispensable be the cost what it may. However, it is not sufficient that the above results are merely possible; it is even more necessary that the results be actually attained. If a result is possible, it can always be attained by proper methods."

In many cases the attempt has been made to impart instruction according to methods previously tabulated and codified, so that the student has little more to do than the filling out of blanks in printed report blanks. Such methods are undesirable in that they leave little or no thinking to be done by the student and may even result in giving him incorrect ideas. Dr. Lucke shows the defects of such routine methods, and prefers what he calls the method of successive problem solution, the student being given graded investigations to work out for himself under the general supervision of the instructor.

"This research, or successive problem solution, method of conducting laboratory work with apparatus of the best seems to promise the student training of the kind that counts for success as an engineer whose whole life is one long succession of meeting and solving problems. The method may differ from what has been defined as the upper limit of methods—pure research—in giving to the student some real help, but not enough to deprive him of the necessity for good vigorous thinking with the pleasure and sense of power which results from success attained after effort. The best form for this help to take is the assignment of a definite piece of apparatus for the solution of every problem and the fitting of that apparatus with the necessary instruments, the manipulation of which may be explained, but no more."

A general account of the methods employed at Columbia University shows that this method is entirely applicable for use in connection with the other departments of instruction to be given in the technical school, and that it succeeds in awakening self-confidence and ambition in the student in a very encouraging manner.

"The working out and interpretation of results calls again for application of all the principles known and comparison with results of other experiments, and might well be the daily experience of any of our best engineers, while the clear writing of a concise report on the whole process is likewise no more or less than common engineering practice. After the solution of some fifty or sixty such problems the student is ready for his thesis problem, which now has no element of mystery, but is a simple, straightforward process, different in detail from anything done, yet no more different than the regular problems were from each other, and again duplicating as nearly as possible conditions to be met in future professional life. In this work, however, the detail of apparatus is a new element and practically the only one, but the thesis is usually more difficult of solution, and calls for all the preparation, skill and power of organization available.

"To sum up the situation discussed, there are different methods of executing laboratory instruction in engineering schools, and these range from the complete written-instruction method, which might be carried out by any intelligent man, to the pure research method, in which a problem is assigned and no assistance given for solution except facilities of laboratory and library. Equipment for such laboratory instruction is also quite various in kind and excellence, but on the average represents large outlays of money for installation and maintenance.

"It is difficult to see how all the schools with variety of apparatus and method of using the same can accomplish the same ends. It does seem, however, that the aim of the instruction or the object to be attained in the student, may justify both method and apparatus, and that old, worn or small pieces will suffice when the aim is to teach the commercial tests, in which case also the complete printed report form is satisfactory. When, however, it is the aim of the instruction to make useful engineers, in the highest sense, by sending out bold and clear-thinking men, well equipped with the fundamental principles and their application, then the modified research method in some form is absolutely necessary. In this case the great range of problems and variety of the scientific foundation material make the most complete laboratory, none too good nor need any part of it lie idle for want of usefulness."

THE PRODUCTION OF POWER GAS.

THE GASIFICATION OF FUELS IN PRODUCERS, WITH ESPECIAL REFERENCE TO THE OPERATION OF INTERNAL-COMBUSTION MOTORS.

Karl Kutzbach—Verein Deutscher Ingenieure.

WITH the increasing attention which is being given to the use of internal-combustion motors there has arisen a necessity for a more scientific treatment of the gas producer, and upon the design of this portion of a gas-power plant much of the success of its performance depends. In a paper presented before the *Verein Deutscher Ingenieure* by Herr Karl Kutzbach, and published in the *Zeitschrift* of the society the subject of gas producers for internal combustion engines is considered very fully and some abstract is here given.

Doubtless the first producers of fuel gas were the blast furnaces used in the smelting of iron, and attempts to use this gas were made as early as 1814 by Aubetot, and more extensively in 1837 by Faber du Faur at Wasseralfingen, but the first systematic production of fuel gas in an independent producer seems to be due to Ebelmen, in France, about 1841. The apparatus of Ebelmen appears to have been very complete, including the preheating of the air, forced blast, and the introduction of superheated steam. By the use of a slag to act as a flux the noncombustible portion of the fuel was fused and drawn off in liquid form, the fuel being introduced by means of a funnel and cone. The gas made in these producers was used in puddling furnaces, and it was not until the introduction of the gas engine that the modern producer of Dowson was made, his patents being dated 1878 and 1883.

The Dowson system includes a producer, a steam boiler, an injector for delivering the air and steam into the generator, and a scrubber, purifier, and holder for the resultant gas. The Dowson system is excellent where the plant is of sufficient importance to warrant the introduction of a works of magnitude, and it remained for the development of the suction gas producer to adapt the method to gas-power plants of all sizes.

Herr Kutzbach lays down the following principles which must be kept in mind in designing a successful gas producer system:

It must utilize the combustible to the best possible advantage, avoiding all loss of heat and producing a gas best adapted for use in the engine.

It must be entirely free from danger when in operation.

The costs of installation and of operation must be reduced to the lowest possible figure.

So far as the loss of heat is concerned, it is impracticable to carry the heat for any distance with the gas, and hence the heat of gasification of the fuel should be used in immediate connection with the producer, as in the production of the vapor and in the preheating of the air. Since the steam delivered into the condenser is decomposed by the incandescent fuel a portion of the sensible heat is utilized in this way, while the superheating of the steam is also effected by the heat of the combustion in the producer.

Herr Kutzbach examines in detail the thermochemistry of the combustion which occurs in the gas producer, taking up the combinations of the oxygen of the air with the carbon of the fuel, and also the decomposition of the vapor of water, with the liberation of the hydrogen and the combination of the oxygen with the carbon. In addition to the chemical equations, the operations are shown graphically, employing the isometric diagram, and thus enabling relations of three variables to be plotted simultaneously.

The combustion in a gas producer takes place very differently from that occurring on a boiler grate, and the temperature is far from uniform in different parts of the apparatus. The temperature increases upwards from the grate until all the oxygen is consumed, after which it diminishes. The formation of carbon monoxide or dioxide depends upon the temperature at each point. The transformation of the carbon dioxide already formed into monoxide occurs in the heated layers and the inverse change in the cooler portions, these going on simultaneously. The gas is thus a mixture of the two formations, changing at different points according to the temperatures. In producers operating at a high temperature the proportion of carbon dioxide is small, running as low as 1 to 2 per cent.

In considering the operation of the gas producer it is necessary to decide upon the most desirable mixture for use in an engine. The combustible elements are the carbon monoxide and the hydrogen, and the relative proportions are variable. The hydrogen has a much lower ignition temperature than the carbon monoxide, and also a much higher rate of combustion. It is also diffused more rapidly into the air, and it requires a greater excess of air for its combustion than the monoxide. In view of these properties it is the proportion of hydrogen which must be considered. If there is too much, the action of the engine will be effected, either by pre-ignition during the compression stroke, or by too violent explosions. If there is too little hydrogen present the gas will be sluggish in igniting. In practice it is found that there should be from 10 to 15 per cent. of hydrogen in the gas, corresponding to about 5 per cent. in the mixture of gas and air delivered to the engine cylinder.

So far as the practical proportions of producers are concerned, these have an important influence upon the performance. The combustion taking place in the interior of the mass of the fuel, the dimensions depend somewhat upon the sizes of the pieces, or rather upon the active surface exposed by the lumps. For convenience in operation it is desirable that a producer should hold enough fuel to be able to run for at least five hours without charging. If the producer is not well proportioned there will be unburned air passing through to the upper portion, and some of the carbon monoxide will be converted into dioxide. The area of the grate should be materially smaller than is indicated for a boiler furnace, this because of the smaller proportion of air required. In ordinary instances the grate may be about one-half the area required for a boiler furnace consuming an equal quantity of coal, and if the draft is assisted the grate area may be made even smaller. The amount of air required is only about one-third that demanded for the complete combustion of the coal in a boiler furnace, and the air spaces in the grate may be proportioned accordingly.

The most serious practical difficulty in the operation of gas producers is found in the formation of slag and cinder. The cinder gathers in the lower portions of the producer, but when it is of a partially fusible nature it forms masses of clinker in the shaft of the producer, requiring to be broken up by poking or barring through holes arranged for the purpose.

Various methods have been devised for removing the cinder. In the blast furnace the flux renders the slag fluid, and it can be tapped off in the liquid form, and this method was also adopted by Ebelmen, as noted above. Another method is that of periodically cooling the producer by the admission of an excess of steam, this causing the cinder to break up more readily. The reversed draft producer is also used to avoid trouble with cinder, the slag being readily removed from the bottom.

So far as the second condition, that of security, is concerned, it is included in ordinary carefulness. The charging should be regularly attended to, and a constant proportion of air and steam supplied. Herr Kutzbach suggests the great desirability of some kind of a device which should indicate continuously the composition of the gas as it is produced, this serving a similar purpose to the pressure and water gauges on a steam boiler. Such an indicator would be of especial value in large plants where the opportunity for variation is greater than in a small installation which may be so adjusted as to be practically automatic.

The economy of gas power installations is fully understood. A gas producer has an efficiency of at least 75 per cent., equal to that of a steam boiler. The efficiency of the gas engine, however, is 25 to 30 per cent., as against 10 to 15 per cent. for the steam engine, the resultant total economy being 40 to 70 per cent. in favor of the gas engine plant. Especially is the advantage seen in the case of small installations, since the small gas engine is as efficient as the large one, while the small steam engine has a far lower efficiency than the above figures.

THE STRENGTH OF METALS AT LOW TEMPERATURES.

EXPERIMENTS RELATING TO THE EFFECT ON MECHANICAL AND OTHER PROPERTIES OF IRON AND ITS ALLOYS PRODUCED BY LIQUID AIR TEMPERATURES.

R. A. Hadfield—Iron and Steel Institute.

IT has long been known that the properties of metals are affected by temperature changes, and many a fracture of a rail or other member in cold weather has been attributed to brittleness caused by the cold. There has been little authoritative information upon the question, however, and hence the paper of Mr. R. A. Hadfield, presented at the recent meeting of the Iron and Steel Institute, is of especial interest.

Mr. Hadfield set out to determine the effects of very low temperatures upon the strength of iron and its alloys, and for this purpose he enlisted the services of Professor Dewar, whose work in the liquefaction of gases and the attainment of low temperatures at the Royal Institution has placed him in the front rank of experimental physicists. A number of experiments had already been made at the Royal Institution upon the action of liquid air upon the properties of various metals, and hence it was decided that similar researches upon the iron alloys would be of practical importance.

Mr. Hadfield prepared a large number of specimens in duplicate, one set of these being delivered to Professor Dewar for test at the temperature of liquid air, while the other sets were tested at ordinary temperature, the work being thus performed upon a scale and according to methods giving results which are entirely comparable

"For the purpose of the experiments, the irons were taken in the form of forged bars, and the iron alloys in the form of cast ingots 2½ in. square. These were carefully heated to the required forging and rolling temperatures, which necessarily varied according to the nature of the material, and were reduced to bars or rods of about ¼ in. diameter. From these bars or rods finished test pieces were prepared in the lathe.

"Quite a number of the alloys were too hard to be machined; in these cases the bars were forged roughly to shape, and then finally finished by grinding to the same dimensions as the machined bars.

"The mechanical tests consisted in determining the tenacity or breaking strength of the specimens, or, more correctly, ascertaining the maximum tensile stress which the specimens stood before breaking; also at the same time obtaining their ductility, as shown by the elongation of each specimen measured over a length of 2 in. The gripping arrangement, to the full depth of the test bar and holder, was immersed in the liquid air.

"The test pieces were allowed to remain several minutes in the liquid air, until all 'boiling effects' ceased. This insured each bar being reduced to the liquid air temperature, that is—182 degrees C. The elongation was taken afterwards, that is, at ordinary temperatures, by clamping the bars together, and noticing the total elongation produced by the tensile stress."

Among the test specimens there was included some of Swedish charcoal iron procured with especial care by Mr. Hadfield to represent as nearly as possible pure iron, these pieces containing 99.82 per cent. of pure iron, with 0.045 carbon, 0.07 silicon, 0.005 sulphur, 0.004 phosphorus, and a trace of manganese. This material, after careful annealing, gave a tensile strength of 20 tons per square inch, with an elongation of 20 per cent. After quenching in liquid air, at a temperature of—182° C., the tenacity rose to 38 tons, and the elongation became zero. A similar specimen immersed in liquid air and allowed to return to the ordinary temperature, 15° C., gave practically the same results as the original, showing that the effect was actually due to the temperature.

The tests with alloys of iron and one, two, or three predominant elements are detailed at length in the original paper of Mr. Hadfield, to which the reader is referred for details, but attention must be called to the fact that the presence of nickel causes the ductility to be retained to a greater or less degree. Thus the presence of about 2 per cent. of nickel causes the elongation of 20 per cent. at ordinary temperatures to be reduced only to about 12 per cent. at the temperature of liquid air, while with 24 per cent. of nickel the elongation of 12 per cent. falls only to 10 per cent. at the low temperature. Most remarkable of all, however, is a specimen containing 1.18 carbon, 6.05 manganese, and 24.30 per cent. of nickel, this showing an actual rise in ductility by the cooling treatment. When this alloy is immersed in liquid air the tenacity rises from 51 to 84 tons per square inch and the ductility from 60 to 67 per cent.

"It is very clear that as regards iron and iron alloys, with, however, certain exceptions, the effect of low temperatures is to increase in a remarkable degree resistance to tensile stress, ordinarily known as the breaking load or tenacity, and to reduce ductility, as measured by elongation, from the highest point, for example, in mild steel 30 to 40 per cent., to practically nil. The changes take place to the same extent, and this is very curious, in the softest wrought iron as represented by the specimens Swedish charcoal iron, and also English wrought iron, and in carbon steel samples from 0.10 per cent., or 0.20 per cent. to the high percentages such as 1.25 per cent., or 1.50 per cent. Thus, the absence or presence of carbon in ordinary carbon steel in which other special elements are not present seems to have but little influence. That there is no error in this statement is proved, independently of the tensile tests, by the fact that several bars of the Swedish charcoal iron and mild steel specimens were submitted to the low temperature test, and tested by hand hammer immediately after immersion. In all cases they exhibited great brittleness, breaking off instantly upon being struck with the hammer; there was an entire absence of ductility.

"Further confirmation is obtained by the Brinell hardness ball test, a method of testing explained elsewhere. Under this test the Swedish charcoal iron specimen at normal temperature had a hardness number of 90, whereas when tested at about—182 degrees C. this increased to no less than 266, or about equal to the hardness of 0.80 per cent. carbon steel at normal temperature. This almost seems incredible when it is remembered that the Swedish charcoal iron shows by analysis 99.82 per cent. of iron, and normally has only 20 to 22 tons tenacity with 25.30 per cent. elongation.

"The importance of the discovery of the toughening effect of nickel upon iron at low temperatures will be seen when it is understood that whilst it has been well known that nickel in certain percentages produced important improvements in the qualities and properties of iron and steel alloys, no microscopical or chemical research work has yet proved why this came about. To the author it seems clear that these experiments go a long way towards offering a satisfactory explanation.

"It will be seen that the purest iron, as represented by the Swedish charcoal iron, containing 99.82 per cent. iron and of specially high quality and purity, becomes brittle to an extraordinary degree under the influence of the low temperature—182 degrees C., whereas nickel itself tested at the same low temperature has improved rather than deteriorated, not only in tenacity, which iron also does, but in ductility, in which latter quality iron entirely breaks down. If nickel, therefore, is present in an iron alloy containing but little carbon or comparatively low in that element, it acts as a preventive of brittleness, or is a very considerable modifier of that objectionable quality.

"It may be interesting to state that at ordinary temperatures the toughness or ductility of nickel is no greater than that of iron. For example, in comparative tensile tests, made by the writer, of nickel and pure iron, the ductility of iron was greater. The reduction of area in the material generally shows its condition as regards ductility; in the specimens in question the reduction of area in the tensile test bars was nearly 20 per cent. greater for iron in both the author's Swedish charcoal iron and Arnold's pure iron than in the nickel specimen.

"Iron to a more or less degree, at any rate in manufacturing operations, always seems to be endeavouring to wander out of the 'paths' of ductility and toughness—it is constantly endeavouring to become brittle. It will often assume its apparently brittle nature on the slightest provocation, and the metallurgist by his arts is always trying to correct this tendency. As with humanity, there seems to be a law of tendencies, and iron by heredity is constitutionally weak. It would appear, therefore, that iron, a cheap and convenient metal itself, must be permeated by some element that will mask or modify its properties. Until comparatively recently carbon was the only element known to modify the properties of iron; but, as will be seen in this research, this element, where great toughness is required, only helps to make matters worse.

"Fortunately for iron, however, its close companion, nickel, singularly enough in the same group, comes along and acts as a friend in keeping it—iron—up to the mark and preventing it from wandering out of the narrow road of metallurgical rectitude, that is, of toughness or ductility. Exactly why this should be so cannot easily be explained, but this is the fact. Possibly some interpenetration of the atomic mass causes a change which cannot as yet be deduced by any known chemical investigations. Iron, too, is a very crystalline metal, whereas nickel appears to be much more amorphous; it is possible, therefore, that nickel tends to prevent iron crystallising in this manner, or prevents it cooling in such large or dangerous type of crystals. This action of nickel is simply marvellous in certain of the alloy specimens, especially in an alloy of iron, carbon 1.18 per cent., nickel 24.30 per cent., and manganese 6.05 per cent. Here the ductility is extraordinary at not only ordinary but low temperatures, probably the highest known for any iron alloy, and certainly for an alloy having such tenacity as 84 tons per square inch. There is still present in this alloy 68 per cent. of iron, yet the tendency of the latter metal to wander into the paths of brittleness is not only entirely checked at the liquid air temperature—and this brittleness, as shown so clearly in this research, occurs to an extraordinary extent in pure iron cooled to—182 degrees C.—but the elongation or ductility already so great is considerably increased, namely, from 60 per cent. to 67½ per cent. There is also an increase of tenacity in both cases, namely, a rise of from 10 to 38 per cent. Thus the nickel present—as these results cannot apparently be ascribed to any other cause—enables the bar under this high tension and at—182 deegrees C. to remain far more ductile than the very best of ductile iron of one-third the tenacity. Although the action of nickel has been specially referred to, it must not be overlooked that in this alloy there is also present 6 per cent. of manganese, which in its ordinary combination with iron, that is, with no nickel present, would confer intense brittleness upon the iron and render it more brittle than if not present. This treble combination of nickel-manganese with iron appears to reverse all the known laws of iron alloys."

THE VALUE OF ALCOHOL FUEL.

A COMPARATIVE STUDY OF THE TRIALS AT THE EXHIBITION OF ALCOHOL MOTORS AT VIENNA.

Lucien Périssé—Société des Ingénieurs Civils de France.

THE question of the availability of alcohol as a fuel for internal-combustion motors, replacing gasoline, benzine, and the other light petroleum products, has been discussed already in these pages, but the subject is too important to be allowed to rest, especially in view of the fact that proper legislation has not yet been effected in countries where it might have been supposed that the industrial and commercial value of the material would have been promptly appreciated.

During the exposition held last year in Vienna the fuel value of denaturized alcohol was very fully tested by conducting a number of trials of various forms of internal-combustion motors with alcohol fuel, and a résumé of these tests has been presented in the form of a paper before the *Société des Ingénieurs Civils de France* by M. Lucien Périssé, from which communication we make some abstract and review. M. Périssé himself had charge of the testing station as well as of the installation of the French exhibits, and hence his opportunities of securing information and data were unsurpassed, while his general familiarity with the subject of internal-combustion motors renders him especially competent to present a technical discussion of this important question.

The motors exhibited represented a number of well-known makes, but the question of the machines was a secondary matter, interest being directed rather to the different varieties of denaturized alcohols, their effectiveness as fuels, and their influence upon the machines in which they may be employed.

The principal tests were made upon a special motor of the Gobron-Brillié type, this being a 10 horse power automobile engine, mounted as a stationary motor for the purpose of the tests. By making the tests of the various fuels upon the same machine the only variable element was the fuel, and comparable results were directly obtainable. In making the trials the performance of the engine was observed by the use of the Mathot continuous indicator, this giving a record of the successive explosions in the cylinders, while the independent indicator diagrams were taken with a separate Garnier indicator. These diagrams were not intended for the determination of the power developed, but only to show the behaviour of the fuel as regards regularity of ignition, completeness of combustion, and general action in the cylinder. The power was measured by the windmill dynamometer of the late Colonel Renard, the instrument used having been especially calibrated by the inventor before and after the tests. This ingenious apparatus has already been mentioned in these columns, but it may be briefly described as consisting of a pair of arms attached to the shaft of the engine, each arm carrying a square vane offering sufficient surface to the air to create enough resistance to absorb the entire power of the motor. The vanes may be adjusted to different distances from the axis, each position offering a resistance requiring a definite power to maintain a given rotative speed. The power required to drive the arms at various speeds is readily determined by running the apparatus with an electric motor, and measuring the electrical energy, and a diagram can be constructed showing exactly the effective resistance of the apparatus at any speed for any position of the vanes. The device has the advantage over the Prony brake of operating well at high speeds, and of requiring no cooling other than that which is effected by the air itself. The only observation required is that of the rotative speed, readily secured by a mechanical counter, the power being subsequently obtained by a simple inspection of the special diagram prepared from the calibration tests of the apparatus. In the Vienna trials the speeds were taken by a Darras chronograph, checked by a Garnier chronometer reading to one-fifth of a second. Tests were made upon other machines, and comparative results obtained, but especial interest attaches to the fuel tests with various kinds of denaturized alcohols.

The most important part of the paper of M. Périssé relates to the different methods of denaturizing alcohol in various countries.

In order that alcohol may be freed from taxation as an intoxicating beverage it is necessary that it shall be so treated as to render it impossible for drinking. The substances added to produce this result should render the alcohol still more effective as a fuel, and should not cause it to be injurious or corrosive to the working parts of the engine. Furthermore, the denaturant must have practically the same boiling point as the alcohol itself, otherwise the mixture could readily be separated by distillation, and pure alcohol obtained for drinking purposes.

The composition of the various denaturized alcohols on the market has been carefully kept secret by the proprietors, and M. Périssé found it necessary to employ a chemist, M. Boulanger, a specialist in this department of organic chemistry, to examine the different specimens submitted and determinne their composition, otherwise the tests would have had their scientific value materially diminished. The chemical examination showed that the materials employed as denaturants are practically limited to four, methylene (CH_4O); pyridine (C_5H_5N), or rather the multiple pyridic bases; acetone, contained in the methylene; and benzole. The alcohol itself is usually 90 per cent. strength, and the different samples examined by M. Périssé were found to have the following composition:

The French alcohol is prepared by taking 100 litres of 90 per cent. alcohol (that is, containing 10 per cent. of water) and adding 10 litres of methylene containing 25 per cent. of acetone and 5 per cent. of hydrocarbon impurities, and also adding 0.5 litre of benzine. This is the standard denaturized alcohol used in France under the existing legal requirements, notwithstanding the efforts of the Minister of Agriculture, the various agricultural societies, and the Automobile Club of France, to permit its modification.

In Austria there are three kinds of denaturized alcohol, the composition being held secret. Leaving aside the varieties intended for burning and for lamps, the variety employed for internal-combustion motors (*motorspiritus*) contains 0.5 per cent. of methylene and 2.5 per cent. of benzole. Germany, like Austria, permits several kinds of denaturized alcohol, according to the intended use. The motor alcohol of Germany contains 1 per cent. of methylene, 0.25 per cent. of pyridic bases, and 2 per cent. of benzole, and a small amount of violet coloring matter. The Italian method is to prepare an official denaturizing liquid, the composition of which is held secret, and 3 litres of this liquid are required to be added to each 100 litres of alcohol. Analysis shows that the denaturized alcohol contains 8.5 per cent. of methylene, 0.65 per cent. of pyridic bases, and about 1 per cent. of benzole, with a coloring of aniline violet.

M. Périssé discusses also alcohols which have been denaturized by the addition of benzole alone, but the results obtained are lacking in definiteness, owing to uncertainty as to the composition of the benzole obtainable at the exposition. In this connection M. Périssé calls attention to the method of preparing such an alcohol, due to M. Hache, this consisting in the addition of the benzole and other denaturizing materials and then redistilling the whole, the product thus consisting of alcohol charged with volatile hydrocarbons of about its own density and having the same boiling point of 78° C. This product contains about 33 per cent. of volatile hydrocarbons, and has been found to give a horse power for a consumption of 600 grammes per hour, which is remarkably low for a fuel containing 66 per cent. of alcohol.

The method of conducting the tests was to equip the motor with the Renard dynamometer, set to a resistance capable of absorbing the full power of the engine. Any lower power was therefore indicated and measured by the extent to which the speed was reduced. The fuels were contained in three tanks, one containing carburetted alcohol for starting and warming up the engine, the second for supplying a standard alcohol, and the third containing the alcohol to be tested. Any one of these tanks could be switched into connection with the feed pipe to the carburetter of the engine, and thus comparative results could be secured without stopping the engine. The correct action of the engine was shown by the Mathot indicator and the speed of the dynamometer gave the information necessary for computing the power, and when all was running smoothly the fuel consumption was measured.

Detailed information concerning the consumptions for the different fuels is given in the original paper, but, in general the consumption ranged from 747 grammes to 1,048 grammes per hour per horse power developed, the best result being given by the Austrian alcohol, and the lowest by the Russian and Swiss products. The French alcohol required 932 grammes per horse power per hour, showing the room for improvement in this mixture, while the German *motorspiritus* gave a horse power for a consumption of 835 grammes per hour.

The data and results of these tests should be useful for those countries which have as yet not fallen into line in permitting the relief of denaturized alcohol from taxation, while the designers of motors for use with alcohol fuel will find much useful information in the report which M. Périssé has made.

A STUDY OF BEARING METALS.

FRICTIONAL CHARACTERISTICS OF BEARING METALS AND THEIR RELATION TO MICROSTRUCTURE.

Melvin Price—American Society of Mechanical Engineers.

NEARLY every problem in machine design has included in it the question of provision for rotating journals and their bearings. Years ago the question of friction was studied experimentally by Morin, and upon the results of those experiments by far the greater proportion of existing bearings has been designed. At the present time, however, engineers are called upon to deal with pressures and speeds so far in excess of those contemplated by General Morin that further investigations have been deemed advisable. At the recent convention of the American Society of Mechanical Engineers a paper was presented by Professor Melvin Price, upon the microstructure and frictional characteristics in bearing metals, this including reference to the work of some of the later investigators. Among these successors of Morin may be noticed especially the work of Charpy, upon the function of hard grains and of the plastic ground mass in the microstructure of alloys; and the theory of Professor Goodman upon the effect produced by elements of high atomic volume as distinguished from the effect of those of low atomic volume in bearing alloys. It was to compare the results obtained by Morin with these later theories that the experiments of Professor Price were undertaken, the methods of metallography being employed in the study of the physical nature of the materials, while some ingenious mechanical and electrical devices were used to determine the friction.

"The laws of friction as announced by Morin were as follows:

"(1) The friction between two bodies is directly proportioned to the pressure, *i. e.*, the coefficient is constant for all pressures.

"(2) The coefficient and amount of friction, pressure being the same, is independent of the areas in contact.

"(3) The coefficient of friction is independent of velocity, although static friction (friction of rest) is greater than friction of motion.

"In direct contrast with the above, we

find the modern beliefs regarding frictional behavior stated by Mr. John Goodman in a review of the results obtained from the testing machines of Thurston, Tower, and Stroudley, as follows:

"(1) The coefficient of friction for moderate pressures and speeds varies approximately inversely, as the normal pressure.

"(2) The frictional resistance varies as the area in contact, the normal pressure remaining constant.

"(3) At very low journal speeds the coefficient of friction is abnormally high; but as the speed of sliding increases from about 10 to 100 ft. per min. the friction diminishes, and again rises when that speed is exceeded, varying approximately as the square root of the speed."

Such contradictory results can only be due to differences in the conditions or the scope of the experiments, and it is these differences which are examined by Professor Price. It is recognized that because one surface is superposed upon another it does not necessarily follow that they are in contact. There are more probably a limited number of points in contact, their area being indeterminate, and when the nominal area is changed the actual area in contact may be only shifted in position to new bearing points without producing any definite change in the actual contact surfaces. Experiments appear to show that Morin's laws may be explained as being obeyed by bodies in contact only at small point areas at which they mesh deeply: that the modern laws are obeyed by bodies in better mechanical contact, but meshing less deeply.

The method employed by Professor Price consisted in the use of a revolving disc, set in motion by contact with a running belt, the disc being painted in alternate black and white quadrants and the retardation being observed through a vibratory stroboscope. By using different bearing metals comparative experiments were conducted, the uncertainty as to the amount of area in contact being eliminated as much as possible by reducing the bearing area under observation.

Experiments made with this apparatus gave data for the plotting of a number of curves, while microphotographs of etched sections enabled the physical constitution of the corresponding bearing alloys to be studied.

The results of the experiments are given in detail in the original paper, but an abstract of the conclusions may be given here. So far as the variation in the amount of the friction with regard to the velocity of sliding is concerned, it seems impossible to establish any definite law. The variations appear to be peculiar to the alloys themselves, although there are often partial similarities. Taking the question of abrasion as a possible basis of study. Here the hardness of the material comes into play, and from this point of view the "asperity" of the bearing metal may be considered. It appeared that mechanical imperfections, microscopical structural features, hard crystals of chemical compounds, and other foreign effects, which make up the *lower orders of asperity,* have a rather constant influence on the resistance. It also appeared that groups of alloys could be formed in which peculiarity of performance went hand in hand with one of the three constituents. This constituent was not noticed in the microstructure, and was called the silent constituent. It may be inferred that such constituents affect the grouping of the atoms, or even of the minute crystals, in such a way as to determine the feature of the higher *orders of asperity.*

It does not seem at all improbable that the lower orders of asperity exert a nearly or quite constant resistance, or that the higher orders exert resistances varying according to the microstructure, although it may also be true that the variations observed are resultants of two or more effects, either of which might be constant if taken separately, but that under varying conditions of speed various portions of each effect enter into the resultant.

With regard to the theory of Charpy as to the residence of the anti-friction properties of an alloy in the hard grains, this is not confirmed by the experiments of Professor Price. The pure metals performed with less resistance than the alloys, and the formation of isolated hard crystals tended to increase the resistance.

The conclusion of Professor Goodman, that the resistance is diminished when the third constituent of an alloy is a metal of high atomic value, does not appear to be inconsistent with the results of the present experiments. While the investigations of Professor Price contain much that is most valuable and suggestive, he himself calls attention to the fact that they must be considered as but tentative, and not to be extended too far, but rather regarded as an effort to reconcile the work of Morin with that of more recent investigators.

COMPRESSION IN STEAM CYLINDERS.

EXPERIMENTAL INVESTIGATIONS INTO THE INFLUENCE OF COMPRESSION UPON THE ECONOMICAL PERFORMANCE OF STEAM ENGINES.

Dr. Herbert Klemperer—Verein Deutscher Ingenieure.

IT is now several years since the experiments of Professor Dwelshauvers-Dery called attention to the fact that the compression of steam into the clearance space of an engine cylinder might be a source of serious loss. Clearance space between the end position of the piston and the head of the cylinder is unavoidable, although it may be reduced to a minimum by care in design and construction, but it had been generally accepted, upon the statement of so high an authority as Zeuner, that the injurious effects of clearance were entirely neutralized when such a degree of compression was employed as would fill this clearance space with steam compressed up to the pressure of the incoming live steam. The experiments of Dwelshauvers, however, showed that increased clearance meant increased steam consumption, even if a corresponding degree of compression was used and the work which he did with the experimental engine in the mechanical laboratory at the university of Liége appeared to sustain his contention very fully. The papers by Dwelshauvers, as well as the discussions which followed, were fully reviewed at the time in these columns, but the question has been revived at the present time by the publication, in the *Zeitschrift des Vereines Deutscher Ingenieure*, of a new series of experiments upon the same subject in the mechanical laboratory of the technical high school at Dresden under the direction of Professor Mollier, these investigations being reported and discussed in an interesting manner by Dr. Herbert Klemperer

The engine upon which the experiments were made was constructed especially for laboratory work, and is of the Corliss type, the point of cut-off being variable by hand, the governor acting only to prevent an excessive speed from being reached. The cylinder is provided with a steam jacket, and the heads are arranged to be moved in or out in such a manner that the clearance may be varied from the normal of 4.5 per cent. to any desired increase. The pipe from the boiler to the engine is only 13 metres long, well covered, and a separator placed close to the engines, and numerous tests have shown the steam to be of uniform quality, containing about 1 per cent. of moisture. The exhaust steam from the engine passed first into a receiver, between which and the condenser was placed a throttle valve. This arrangement was found necessary in order to obtain a back pressure high enough to enable the desired degrees of compression to be attained. The condensed steam was carefully collected and weighed, including the drip from the exhaust receiver and from the jacket. The engine was carefully tested for tightness of valves and piston, and all the testing instruments were calibrated with care.

The engine was connected to an independently-excited dynamo, the current being passed to a resistance of nickelin, and by the regulation of the load the speed of the engine could be maintained at any desired number of revolutions for the admission and cut-off selected. The general details of the trials appear to have been given every care, and the results are entitled to corresponding consideration.

Dr. Klemperer examines the theory of compression of steam, and accompanies each indicator card with an auxiliary diagram showing the condition of the steam during compression, the ordinates representing the quality of the steam considered in comparison with the specific volume of dry saturated steam of the same pressure, while the abscissas represent the successive volumes during the compression.

Comparison of a series of diagrams, together with tabulated results of tests at various cut-offs and compressions show that the heat exchanges during compression bear an important relation to the economical performance of the engine. For the numerous curves and the tables of data and results the reader must be referred to the original paper, but in general the conclusions may be given here.

The results naturally varied somewhat with the operative conditions, including the ratio of cut-off, the presence or absence of steam in the jacket, and the degree of back pressure. In general, however, a moderate degree of compression was accompanied with a slight improvement in performance, beyond which there was a marked increase in steam consumption, reaching as high in some cases as more than 20 per cent. advance over the consumption at normal compression.

This loss is evidently due to the same cause as was ascertained by Professor Dwelshauvers, being due to what he called the anticipatory condensation of the exhaust steam as its pressure and temperature rose in the course of the compression. The compression does fill up the clearance space and raise the temperature to that of the incoming steam, but, as Professor Boulvin put it: "it is more economical to reheat the walls by live steam than by the work of compression, because this work, being derived through a cycle of low efficiency involves a large expenditure of heat.'"

Dr. Klemperer states the matter in much the same way when he says: "The condition under which compression is advantageous is that the temperature at the end of the compression shall not exceed that of the cylinder walls, so that the maximum economical compression at the end of the stroke is that corresponding to the temperature of the walls." If the compression is increased beyond this point the economy of the engine will fall off, and according to the experiments at Dresden, the steam consumption will increase in proportion to the ratio of the volume of the compressed steam to the volume of live steam in the cylinder.

WINDING ROPES FOR MINES.

CAUSES FOR THE REDUCTION IN STRENGTH OF WINDING ROPES FOR USE WITH MINE HOISTS.

J. A. Vaughan and W. M. Epton—Transvaal Institute of Mechanical Engineers

WITH the continually increasing depth of mine workings in various parts of the world there has been shown a growth of interest in hoisting machinery and appliances, and several papers of importance upon this and allied subjects have been recently reviewed in these pages. Nearly all the discussions have related to the winding machinery itself, including the systems employed, the engines, motive power and similar features. In all of these methods, however, the winding rope itself forms an essential part, and upon its strength and durability the success of any system must depend.

In a paper recently presented before the Transvaal Institute of Mechanical Engineers, Messrs. J. A. Vaughan and W. M. Epton discussed the strength of winding ropes and the reduction in their sustaining power in the course of service, and some review of the results of such experience will be of interest to mine operators in other places.

A winding rope should be chosen in the first place with regard to the work it has to perform, and the conditions under which it is operated. The duties of different ropes employed under identically the same conditions are capable of comparison, but the duty of one particular rope in comparison with that of another rope working under different conditions is a difficult matter to determine. When, as in the first case, the operative conditions are the same, the duty may be determined by dividing the total amount of ore hoisted by the cost of the rope. A more general rule suggested by the authors is to divide the mileage run by the factor of safety, this latter term being estimated by considering the total effect of all the destructive influences, and not merely the statical load. The deterioration of a winding rope may take either any, or all, of the three following forms:

1. Decrease in the sectional area of the wires:
2. "Fatigue" or change of state of the steel, *i. e.*, loss of certain desirable qualities, such as ductility, originally possessed by the material;
3. Discontinuity of the wires due to their breaking.

The oxidation of steel or iron, commonly known as rusting, is especially rapid and far-reaching, because the rust first formed does not protect the rest of the metal, but rather increases its corrosion. The simultaneous presence of H_2O, O_2 and an acid (generally H_2CO_3), is necessary for the rusting of iron, but little rusting occurs in the absence of any one of these there. Moreover, the presence of an alkali, or even an alkaline carbonate, prevents rusting.

In wrought or ingot iron the corrosion rises with the percentage of carbon, and this applies to steels with much combined carbon. Rusting is increased by galvanic action—as, for instance, tin-plate when the tin coating is broken. Similarly with iron railings coated with lead, corrosion occurs just above the junction of the metals. The same applies to copper-covered iron, the protection being satisfactory only so long as the coating is perfect. Galvanised steel (with zinc) on the other hand rusts less than steel, since zinc is attacked first, but it is very susceptible to chlorides (*e.g.* sea water), and also will not stand the action of the free acid in some mine waters. The thin coating of zinc on the wires of a winding rope will very soon be worn through at the places where external or internal rubbing occurs.

Regarding the deterioration due to "fatigue" or change of state of the steel, it is well known that the frequent application of a load, well below that producing stress up to the elastic limit, eventually produces "fatigue" in steel. Reversals of the load accelerate this action. The fatigue shows itself by the steel becoming brittle. Whether this is due to an alteration in the arrangement of the molecules of the steel, this changing from the fibrous to the crystalline structure is a point on which scientists do not agree. Most certainly the wire becomes brittle and behaves as if the structure of the steel had become crystalline.

In local practice it has certainly been found that the brittleness in a rope is much more marked when it is subjected in winding to a large number of reverse bends, and it is very probable that a winding engine with a light drum will also cause the same results on account of the uneven turning moment on the drum shaft. The writers have examined one winding plant where these results have occurred under the conditions stated. In this case the ropes only last about sixteen or eighteen weeks; broken wires begin to appear after the rope has been about a month in use, after which time the number increases very rapidly from week to week, until, in about the sixteenth or seventeenth week, as many as ten wires break each day. It is found that the condition of the wire is such that 180 degs. bend will break it, whereas it took eight or nine bends to accomplish this when the wire was new. In this particular case there was very slight frictional wear on the wires, which were practically their full size.

In another case, micro-photographs were taken of wires in a rope, samples being cut from a very much worn part, and also from the end which had been coiled spare on the drum and which had therefore been subject to very little stress, and it was found that in the former case the molecular structure was entirely different from that in the latter. In this instance, however, the wires were much reduced in size, due to wear, frictional or corrosive, or both. The former case cited, in which the rope has been put out of use on account of a very large number of breaks in the wires, is not a solitary case. Until further information as to the real cause of the deterioration is furnished, it is popularly attributed to "fatigue" of the steel, and it is generally supposed that the more bendings there are in the journey of the rope, and the more frequently reversals occur, the shorter the life that may be looked forward to for the rope. There are, however, other causes that may tend to the peculiar effect of loss of ductility, while original size and appearance remain practically intact.

Safety in winding ropes can be secured

only by frequent, careful inspection. In the Transvaal a daily examination is required besides a thorough inspection once a month, the rope being thoroughly cleaned at selected places in order that its true condition may be ascertained. By running the winding engine slowly the rope may be examined throughout its entire length, the signals being so arranged that it can be stopped immediately upon call for a special inspection of any particular spot.

The places in a rope demanding especial attention are those where contact with sheaves and pulleys occur at acceleration or retardation periods of the hoist, also the portion nearest the skip or cage where there is apt to be an accumulation of moisture, both external and internal. It is recommended that recapping be done at intervals of about three months, thus shifting the points of greatest wear and at the same time removing the portion of the rope subjected to the most severe kinetic stresses.

A SEA LEVEL CANAL FOR PANAMA.

A CONVERTIBLE LOCK-SYSTEM FOR ULTIMATE TRANSFORMATION INTO A SEA-LEVEL CANAL.

Philippe Bunau-Varilla—Académie des Sciences.

NEARLY all of the plans which have been proposed for the Panama Canal involve a number of locks, these permanently maintaining a summit level, and intermediate levels above the sea, and to these must be added the sea-level plan, which calls for the cutting of the whole channel down to the level of the ocean. To these we now have another plan due to M. Bunau-Varilla, and described by him in a communication presented to the French Académie des Sciences, and further elaborated in a letter which he has addressed to the President of the United States. This plan may be called a combination of the previous ones in that it includes the construction of a summit-level lock canal, but so arranged that it may gradually be lowered as the traffic increases, until ultimately the sea level is reached. The method by which this may be accomplished is explained in detail, and the whole scheme possesses some ingenious original features.

In order that the canal may be opened for traffic within the shortest possible time, M. Bunau-Varilla proposes to begin with a summit level of 130 feet. The cut at Culebra has already been brought down to a level of 150 feet, so that a further reduction of 20 feet would be sufficient; this summit level extending across the central massif, between Gamboa and Paraiso. This work, it is estimated, could be completed within four years. At each end of this summit level would be placed two locks, of 35 feet lift, or a total of 70 feet, bringing the channel down to the 60-foot level, which again would be brought down to sea level on the Atlantic side by a flight of locks at Bohio, and on the Pacific side by two locks, at Pedro Miguel and Miraflores, or other suitable points.

The auxiliary works include a dam at Bohio, and a spillway, and the plan adopted for this by M. Bunau-Varilla is practically that proposed by the late George S. Morison, consisting of a mass of earth and clay from 2,500 to 3,000 feet thick, hydraulically deposited between two enclosing dams, and forming a solid neck of land across the valley. The seepage beneath such a dam, only 60 feet high, would be insignificant, practically less than the loss by evaporation.

The dam at Gamboa should be built of reinforced concrete, and may be constructed to a height of 150 feet above sea level in the opinion of M. Bunau-Varilla, within the four years required for the works at Culebra, and this time is also ample for the construction of the locks and other auxiliary works.

Such a canal, it is estimated, would suffice for a traffic of 50,000,000 tons or five times the present capacity of the Suez Canal, while at the same time the level could be gradually reduced and the locks removed until a sea level channel is attained throughout.

The method by which this latter result may be accomplished constitutes the characteristic feature of the scheme. The principle of the method appears in a modification in the construction of the locks and lock gates. In the ordinary construction it would be altogether possible to deepen an upper level to any desired extent with the exception of the end portions near the locks, but to effect the complete lowering of the channel by the removal of the locks themselves would involve a serious interruption to traffic. The modification of M. Bunau-Varilla to avoid this difficulty is simplicity itself, since it requires merely the original construction of the lock chambers and gates to the full depth of the reduction in lift at each point, the full depth also being carried back a few hundred feet from the lock at each end of a level. This would render it impossible to effect a continual deepening of the stretch between the locks without any further consideration of either gates or lock masonry.

To use the words of M. Bunau-Varilla: "The method consists simply in giving to the gate above the lock the same height as the gate below, and the same level of foundation. Of course the ground forming the bottom of the summit level will have to be excavated down to the level of the bottom of the adjoining navigable level, for a distance of 400 to 500 feet above the gate of the lock. It can no longer be limited by the wall which in ordinary locks supports the gate above, and at the same time acts as a retaining wall for the ground above.

"The locks being thus arranged, if we dredge five feet into the bottom of the summit level we shall not touch during such dredging any vital part of the canal; the locks will remain precisely as they are. When the dredging is finished, as we have five feet too much depth of water in the summit level, there is nothing to prevent lowering the water level five feet.

This will not in the least interfere with the operation of the locks. When this is done the ships will still find the 35 feet depth of water which they require, and nothing will have been changed, except that the canal will then have the summit five feet less above the sea level than before.

This operation may be repeated until the entire lift has been removed, after which the lock gates are no more required and may be taken off, navigation not having been interrupted at all. In this way a gradual transformation from a lock canal into a sea level channel may be going on continuously, while at the same time traffic is going on. At Suez the canal was cut to sea level at once, the sandy isthmus being sufficiently near the level of the sea to render this a comparatively simple matter. The channel, however, has been both deepened and widened, without interrupting traffic.

An ingenious feature of the scheme of M. Bunau-Varilla is that for the disposal of the spoil removed in the deepening of the upper portion of the channel. This plan is nothing more nor less than the conveyance of the earth in scows up to the lake formed behind the Gamboa dam. Even if the canal is finally excavated to a bottom width of 300 feet it is estimated that the amount of earth would form a deposit only eight feet in depth on the bottom of the lake, and since the depth of water would be 145 feet.

"This solution can be easily realized by connecting the waters of the lake with those of the summit level by a double flight of locks. The material extracted by the dredges would be dumped into scows which would be tugged along the summit level in the channel opened outside of the navigation channel, and after ascending the flight of locks, go into the Gamboa lake and simply unload themselves by opening their bottom gates."

There are numerous details in the plan which appear to have been worked out with care, and the whole scheme demands the consideration which it will doubtless receive at the hands of the Commission and the Advisory Board. The real point to be considered about it is whether a sea level canal is really desirable at all. M. Bunau-Varilla admits that a canal with 130-foot summit level, and with eight locks, is fully capable of taking care of an annual tonnage fully five times as great as that acquired by the Suez Canal after thirty years of operation. Such being the case, there is every reason to believe that the 20.75 metre (68 feet) level approved by the *Comité Technique* would suffice for any traffic which might be expected, and certainly that the 9.75 metre level (32 feet) would be sufficient. If these plans, so fully worked out, are ample, there need be no further preparation made for a sea level channel, and the ingenious plan of M. Bunau-Varilla would be found unnecessary.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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Concrete Arch Over the River Tay at Kinclaven. Illustration with brief description of a structure built entirely of concrete, faced with red freestone. 700 w. Engng—May 12, 1905. No. 69830 A.

Concrete-Steel Arch Bridge at Kankakee, Illinois. J. B. Marsh. Illustrated detailed description of the construction. The bridge is so designed that the grade forms a vertical curve, with the center 2½ feet higher than the ends. General discussion. 4300 w. Jour W Soc of Engrs—April, 1905. No. 69686 D.

Erection of the Bellows Falls Arch Bridge. Brief illustrated description of a bridge across the Connecticut River, of interest on account of its long span, and the type of suspended floor. 1200 w. Eng Rec—April 29, 1905. No. 69318

Reinforced Concrete Arch Bridge at

Yorktown, Ind. Illustrated description of the construction of a reinforced concrete arch bridge of 95-ft. span, with the thrust resisted by a tie connecting the skewbacks across the bed of the stream. It is the longest span of the Luten type ever erected. 1600 w. Eng News—May 11, 1905. No. 69492.

Blackwells Island.

Details of Blackwells Island Bridge Superstructure. An illustrated detailed description of this bridge from East Fifty-ninth St., Manhattan, across the East River and Blackwells Island, New York, to Ravenswood. 2000 w. Eng Rec—May 20, 1905. Serial. 1st part. No. 69812.

Cantilever.

The Mississippi River Bridge at Thebes. Illustrated detailed description of interesting features of this large cantilever bridge. 1500 w. R R Gaz—Vol. XXXVIII., No. 21. No. 69874.

The Mississippi River Cantilever Bridge at Thebes, Ill. Illustrated detailed description of one of the most notable bridges in the United States, costing about $2,800,000. 4500 w. Eng News—May 11, 1905. No. 69494.

Drawbridge.

The Hansa Bridge at Stettin (Die Hansabrücke zu Stettin). A fully illustrated account of the new bridge over the Oder at Stettin. There are two shore spans of 37.2 metres, and an electrically operated rolling-lift draw of 18 metres. 6000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69707 D.

Scherzer Lift Bridge Over the River Swale; Foundation Details. Drawings and notes introductory to a description of the erection and of the opening leaf. 500 w. Engng—May 12, 1905. Serial. 1st part. No. 69829 A.

Short Span Bascule Bridge on the Pittsburg, Fort Wayne & Chicago Ry. Illustrations, with brief description of a double-track, short-span, single leaf bascule bridge of peculiar design, at Delphos, Ohio. 600 w. Eng News—May 25, 1905. No. 69863.

Erection.

Substructure and Falsework Construction for the Gilbertsville Bridge. Illustrates and describes the construction of this bridge across the Tennessee River at Gilbertsville, Ky. The substructure for the main spans consists of six river piers and two shore piers, all made of reinforced concrete. 1000 w. Eng Rec—May 20, 1905. No. 69807.

Oder.

Plans for a Combined Railroad and Highway Bridge over the Oder at Neusalz (Entwurfe für eine Vereinigte Eisenbahn- und Strassenbrücke über die Oder bei Neusalz). F. Dircksen. With details of the designs of various competing firms, including braced arches, trusses, and cantilevers. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—April 15, 22, 1905. No. 69700 each D.

Ottawa River.

The Bout de L'Isle Bridge. J. L. Morris. Illustrated description of a bridge crossing the east and west branches of the Ottawa River just above the junction with the St. Lawrence. 2000 w. Can Soc of Civ Engrs—April 20, 1905. No. 69647 C.

Piers.

Design and Construction of High Bridge Piers of Reinforced Concrete. William M. Torrance. Gives calculations made for the design of piers of a bridge across the Tennessee River, on the Louisville Div. of the Illinois Central R. R. Also gives notes on construction. Ills. 4000 w. Eng News—May 25, 1905. No. 69865.

Plate Girder.

The Pine Creek Long-Span, Plate-Girder Bridge. Illustrated description of a double-track skew deck bridge having three duplicate main spans of 127 ft. 10 in., and one 33 ft. 8 in. approach span. 1500 w. Eng Rec—May 6, 1905. No. 69454.

Railroad Bridges.

The Development of Railroad Bridge Design and Construction. Henry W. Hodge. A general review of progress, with illustrated examples of modern work and description of details in present practice. 3000 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69430.

Reconstruction.

The Reconstruction of the Maximilian Bridge at Munich (Die Rekonstruktion der Maximiliansbrücke in München). Prof. Mörsch. An account of the method employed in replacing a hinged masonry arch which had slipped from its hinges. 2000 w. Schweiz Bauzeitung—May 13, 1905. No. 69733 B.

The Reconstruction of the Point Bridge, Pittsburg. Describes work on this bridge across the Monongahela River, describing the old bridge, the condition before repairs, and the reinforcement of anchorages in the present article. Ills. 2700 w. Eng Rec—May 6, 1905. Serial. 1st part. No. 69450.

Renewals.

The Erection of the Short Line R. R. Bridge at Minneapolis. An illustrated article describing the building on the same alignment, without interrupting traffic, of a heavy double-track structure to replace a light single-track bridge across the Mississippi River. 1200 w. Eng Rec—May 20, 1905. No. 69806.

Suspension.

Making the Cables of a Large Suspension Bridge. Isaac Harby. A detailed description of this work on the Williamsburgh Bridge, across the East River, at New York. Gives brief description of the bridge, also. Ills. 6500 w. Cassier's Mag—May, 1905. No. 69283 B.

Transporter.

Transporter Bridge Over the Mersey. An illustrated description of a bridge of the "suspended ferry" type, recently completed. 2500 w. Engr, Lond—May 5, 1905. No. 69599 A.

Trusses.

A Comparison between the Exact and Approximate Methods of Computation for Bridge Trusses (Genauere Behandlung Statisch Unbestimmter Parallelträger und Vergleich mit der Näherungsrechnung). Friedrich Hartmann. With tables of both computations, showing variations of 25 to 33 per cent. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—April 28, 1905. No. 69730 D.

Some Primary Truss Principles. Myron S. Falk. Shows that trusses whose outlines contain rectangles, or even other polygonal figures, may be stable and statically determinate. 1700 w. Sch of Mines Qr—April, 1905. No. 69634 D.

Viaduct.

The Austerlitz Viaduct over the Seine (Viaduc d'Austerlitz sur la Seine). A. Dumas. An illustrated description of the bridge recently completed to carry the Metropolitain railway across the Seine at Paris. 3000 w. 1 plate. Génie Civil—April 29, 1905. No. 69719 D.

The Southwestern Ave. Boulevard Nine-Track Viaduct in Chicago. Illustrated description of an unusually wide viaduct made necessary by track elevation improvements. 2000 w. Eng Rec—April 29, 1905. No. 69319.

CONSTRUCTION.

Balcony.

Semicircular Symmetrically Loaded Balcony Beams (Der Halbkreisförmige und Symmetrisch Belastete Balkonträger). G. Ramisch. A mathematical treatment of the forces acting upon a semi-circular beam with ends built into a wall, forming a balcony. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—April 7, 1905. No. 69726 D.

Building Construction.

Structural Features of Rockefeller Building at Cleveland. Illustrated description of interesting features of a 17-story, steel-cage, fireproof office building. 1500 w. Eng Rec—May 27, 1905. No. 69912.

Dams.

Note on the Theory of Unsymmetrical Masonry Dams. Prof. W. C. Unwin. Explains a method of determining the distribution of the shearing stress on horizontal sections. 1600 w. Engng—April 21, 1905. No. 69336 A.

Further Note on the Theory of Unsymmetrical Masonry Dams. Prof. W. C. Unwin. Examines the stresses in a triangular dam, by the method already given. 1200 w. Engng—May 12, 1905. No. 69827 A.

Doors.

A Novel Balanced Door. Illustrated description of the invention of Joseph Henry Dierickx, a Belgian inventor, which consists of two leaves so pivoted that they will slide into partitions. 500 w. Sci Am—May 6, 1905. No. 69392.

Folding Doors for Freight Houses and Warehouses. Illustrates and describes the Ritter door, and the Cross door, two types which fold vertically. 600 w. Eng News—May 4, 1904. No. 69365.

Foundations.

Concrete Foundations of the New Passenger Station, Washington, D. C. Day Allen Willey. A brief description of this interesting edifice, giving details of the elaborate substructure. Ills. 1200 w. Sci Am—May 20, 1905. No. 69621.

Underpinning and Protecting the Foundations of the Times Building, New York. Illustrates and describes methods of underpinning the building at the corner of Spruce St. and Park Row, made necessary in constructing the City Hall loop of the Rapid Transit Subway. 1200 w. Eng Rec—May 27, 1905. No. 69910.

Pile Driving.

The Use of a Novel Water Jet for Driving Piles for the Sandy Hook Proving Ground Railroad Trestle. Sherman A. Jubb. An illustrated description of the method used in pile sinking. 1200 w. Eng News—May 4, 1905. No. 69366.

Power House.

A River-Bed Power House. John M. Bruce. Illustrates and describes a power house and pulp mill at Berlin, N. H., as an interesting example of concrete construction under great natural difficulties. 1200 w. Cement Age—April, 1905. No. 69353.

The Use of Concrete in an Electric Power Station. Eugene B. Clark. Read before the Chicago Branch of the Am. Inst. of Elec. Engrs. Considers the use of cement in foundations, floors, roofs, &c., especially considering a recently completed plant in South Chicago. 3000 w. Eng News—May 4, 1905. No. 693[illegible]

Reinforced Concrete.

A Prominent Building of Reinforced Concrete Construction. Illustrated description of the Pugh Power Building, in course of construction in Cincinnati. 2000 w. Cement—May, 1905. No. 69840 C.

A Reinforced Concrete Building for a Philadelphia Printing Company. Illustrates and describes interesting work in the reconstruction of a brick building, to render it more nearly fireproof. 1300 w. Eng Rec—May 13, 1905. No. 69574.

Concrete Construction. Edward Atkinson. Discusses the use of concrete construction for factories, shops and other works, and for dwelling houses and warehouses. 2400 w. Cement Age—April, 1905. No. 69352.

Distribution of Shear Over Section, for Reinforced Concrete Beams. John G. Little. Gives solution. 300 w. Eng News—May 25, 1905. No. 69864.

Reinforced Concrete Building Work for the United Shoe Machinery Co., Beverly, Mass. George P. Carver. Illustrated detailed description of a plant consisting of ten buildings, all built of reinforced concrete. The construction work is fully described. 5000 w. Eng News—May 25, 1905. No. 69861.

Reinforced Concrete. Editorial discussion of this building material and its use. 2200 w. Engng—April 28, 1905. No. 69479 A.

Static Investigation of a Curved Prismatic Compound Beam (Statische Untersuchung eines Einfach Gekrummten Stabförmigen Verbundkörpers). G. Ramisch. An examination of the distribution of stresses between the iron and concrete in a deflected beam. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—April 29, 1905. No. 69762 D.

The Design of Reinforced-Concrete Beams. George H. Blakeley. Presents some formulas for transverse strength of the simple case of reinforced concrete slabs for floor construction. 4000 w. Eng Rec—May 27, 1905. Serial. 1st part. No. 69909.

The Iowa State Highway Commission's Designs for Culverts. T. E. McDonald. Read before the Iowa Cement Users' Assn. On designs for reinforced concrete box culverts, and their construction. 2500 w. Munic Engng—May, 1905. No. 69542 C.

See Civil Engineering, Bridges.

Roads.

Marsh Roads. Stillwell H. Townsend. From a paper in the Report of the N. J. Commissioner of Highways for 1904. Describes the construction of a road through the salt marsh from Rio Grande to Holly Beach. 800 w. Eng Rec—May 13, 1905. No. 69573.

The Charles River Speedway of the Boston Metropolitan Park System. William T. Pierce. Illustrated detailed description of a speedway costing about $450,000. 2500 w. Eng Rec—April 29, 1905. No. 69321.

Steelwork.

Steelwork in the Twin City Rapid Transit Company's Power House, Minneapolis. Describes the steel work of a building at present containing about 2,060 tons of structural steel, illustrating details. 2200 w. Eng Rec—May 13, 1905. No. 69576.

Tunnels.

The First Street Tunnel, Washington, D. C. Illustrated description of construction work on the double-track tunnel being built to connect the passenger tracks of the Pennsylvania R. R. with the new union terminal station. 2000 w. Eng Rec—May 20, 1905. Serial. 1st part. No. 69805.

MATERIALS OF CONSTRUCTION.

Bricks.

Glass Paving Bricks. A. M. Thackara. Describes the processes used in making artificial stone, paving brick and other products from old glass, as manufactured in France under the Garchey patents. 1600 w. Eng Rec—May 20, 1905. No. 69809.

Results of Tests of Common Building Brick for the Bureau of Buildings, New York City. Ira H. Woolson. Reports tests of transverse and crushing strength, also absorption, fire, and freezing tests. 2700 w. Clay Rec—April 29, 1905. No. 69377.

Cement.

A Comparison of the Theoretical with the Actual Fuel Consumption in Cement Burning. Henry S. Spackman. Read before the Assn. of Am. Port. Cem. Mfrs. An explanation of the methods of making calculations, giving the results. 3500 w. Eng Rec—April 29, 1905. No. 69320.

Cement Testing. Robert Gray. Describes briefly methods of testing to determine the quality. Ills. 1200 w. Yale Sci M—May, 1905. No. 69839 C.

Portland Cement. H. K. G. Bamber. Read before the Soc. of Archts. Describes processes of manufacture, considering particularly cement manufactured with chalk and clay. Also points on the testing of cement. 6500 w. Archt, Lond —April 21, 1905. No. 69324 A.

Prospecting and Sampling Deposits of Raw Material for Portland Cement Manufacture. Gives briefly instructions laid down by Albert V. Bleininger in a report to the Ohio Geological Survey. 2500 w. Eng News—May 11, 1905. No. 69493.

Recent Results Obtained with the Kent Mill as a Fine Grinder. George H. Fraser. Address before the Assn. of Am. Port. Cement Mfrs. upon the grinding of cement. 4000 w. Cement—May, 1905. No. 69841 C.

Slag Cement. W. B. Ruggles. Reviews the early use of this material, the industry in the United States, and recent advances. 2000 w. Ir Age—May 18, 1905. No. 69611.

Tests of Cements at the Watertown Arsenal. James E. Howard. Read before the Assn. of Am. Portland Cem. Mfrs. Report of tests made during the past four years. 4500 w. Eng Rec—May 6, 1905. No. 69451.

The Government Cement Mill at Roosevelt, Arizona. H. B. Connor. Gives a statement of the amount saved by manufacturing on the ground the cement needed for the construction of the Salt River reclamation project, describing the plant. 1500 w. Min Wld—May 20, 1905. No. 69693.

The Influence of Sulphates on the Setting of Cement (Influence des Sulfates sur la Prise du Ciment). Louis Périn. With diagrams showing the effect of the addition of a small quantity of plaster to Portland cement. 1500 w. Génie Civil —April 15, 1905. No. 69714 D.

Stone.

Quarrying and Crushing Stone. J. Crow Taylor. Information of interest in regard to the stone-crushing industry, giving figures relating to the quarrying and crushing of limestone. 2000 w. Munic Engng—May, 1905. No. 69540 C.

MEASUREMENT.

Geodesy.

Report of the Equatorial Geodetic Commission (Rapport Présenté au Nom de la Commission Chargée du Contrôle Scientifique des Operations Géodésiques de l'Equateur). Describing the work of the French expedition in Ecuador during 1904. 3500 w. Comptes Rendus—April 10, 1905. No. 69721 D.

Surveying.

The Laying Out of City Lots Bounded by Curved and Straight Lines. Ernest McCullough. Gives an explanation of the practice followed by the writer, illustrating by plan. 1100 w. Eng News—May 11, 1905. No. 69497.

The Practice of Our Profession and Suggested Reforms. A. G. Cross. Read before the Quantity Surveyors' Assn. The first part of the paper is a plea for a uniform system of measurement in England; the second part deals with reforms in the employment and payment of the quantity surveyor. 6500 w. Builder—April 22, 1905. No. 69323 A.

The Stadia-Intersection Method for Topographical Surveys. Prof. L. E. Ashbaugh. Describes a method of intersections from stadia base lines which has proved efficient and rapid in securing desired results. General discussion. 5500 w. Jour W Soc of Engrs—April, 1905. No. 69687 D.

Temperatures.

See Civil Engineering, Waterways and Harbors.

Viagraph.

The Viagraph: An Instrument for Measuring Road Wear. Charles Lavell. Illustrated description of an ingenious invention for measuring and registering wear in road surfaces. 500 w. Sci Am—May 13, 1905. No. 69487.

MUNICIPAL.

Paving.

Concrete Paving and Paving Materials. H. L. Weber. From a paper before the Ohio Soc. of Surv. & Civ. Engrs. Directions for the construction of concrete roadways, their foundations, pavement, &c. Ills. 1200 w. Munic Engng—May, 1905. No. 69541 C.

Pollution.

Report of the New York Bay Pollution Commission. Extracts from the report, showing reasons for the unqualified disapproval of the Passaic Valley trunk sewer scheme. Editorial also. 5500 w. Eng News—May 1, 1905. No. 69370.

Sewers.

Concrete in Sewer Construction. W. C. Parmley. Discusses the advantages of concrete as a material aid in comparative cost, and gives notes from personal experience. 4500 w. Cement Age—May, 1905. No. 69896.

Sewage Discharge into New York Bay. Review of the report of the New York Bay Pollution Commission. Map. 2700 w. Eng Rec—May 6, 1905. No. 69452.

Sewer Tunneling with a Shield in Cleveland. J. M. Estep, in the *Polytechnic*. An interesting account of the construction of a sewer under conditions that make the work very expensive. 1800 w. Eng Rec—May 6, 1905. No. 69449.

The New Outfall Sewer at Los Angeles. Illustrated detailed description of work under construction. 1800 w. Eng Rec—May 13, 1905. No. 69570.

WATER SUPPLY.

Coney Island, N. Y.

A High Pressure Water System at Coney Island, N. Y. Illustrates and describes the system under construction which will furnish fire protection to this seashore summer resort. 1800 w. Eng Rec—May 20, 1905. No. 69813.

Copper Sulphate.

Copper as an Algicide and Disinfectant in Water Supplies. Karl F. Kellerman. Abstracted from Bul. No. 76 of the Bureau of Plant Ind., Dept. of Agri. Gives results of laboratory work, and practical applications of this method. 2200 w. Sci Am Sup—May 20, 1905. Serial. 1st part. No. 69628.

Dams.

See Civil Engineering, Construction.

Drinking Water.

Desert Plants as a Source of Drinking Water. Frederick V. Coville. An illustrated article giving information in regard to these plants, and the ability of animals feeding upon them to go without water; also describes an Indian's method of obtaining water from them. 2500 w. Sci Am Sup—May 27, 1905. No. 69870.

Filtration.

The Work of the Philadelphia Water Filters. Notes taken from an address by John W. Hill before the Engng. Soc. of Princeton University. 1200 w. Eng Rec—May 13, 1905. No. 69571.

Irrigation.

Irrigation in Canada. An account of work accomplished and projected in the Saskatchewan valley. 1500 w. Engr, Lond—May 12, 1905. No. 69835 A.

Mechanical Filters.

Tests of Copper and Iron Sulphates and Lime with Mechanical Filters at Anderson, Ind. Information from a paper by C. Arthur Brown, read before the American Water Works Association. 2500 w. Eng News—May 25, 1905. No. 69866.

Meters.

Meters for Fire Service. Gorham Dana. Discusses the question of metering fire service connections from public water systems, different types of meters, and gives table of tests showing effect of meters on flow of water. Ills. 5500 w. Ins Engng—May, 1905. No. 69876 C.

Pollution.

Report on the Pollution of Lake Champlain, the Boguet and Au Sable Rivers by Wood Pulp Mill Refuse and by Algæ. Abstracts of the reports of Olin H. Landreth and of G. C. Whipple, giving conclusions and recommendations. 8000 w. Eng News—May 25, 1905. No. 69862.

Private Companies.

The Eminent Domain of Private Water Companies. Houston Dunn. Discusses the growing menace of private ownership and matters of related interest. 2500 w. Ins Engng—May, 1905. No. 69877 C.

Pumping.

See Mechanical Engineering, Hydraulics.

Purification.

The Coagulation and Precipitation of Impurities in Water Purification. Joseph W. Ellms. Read before the Cincinnati Sec. of the Am. Chem. Soc. Comments on observed facts in water purification in the light of physical chemistry, describing investigations made of the Ohio River water. 3800 w. Eng Rec—May 13, 1905. No. 69575.

Reservoirs.

A Concrete Settling Reservoir at McKeesport, Pa. The reservoir described and illustrated was built by the National Tube Co., to purify the water of the Monongahela River to render it fit for use in the boilers and hydraulic machinery. 2000 w. Eng Rec—May 27, 1905. No. 69911.

Completing the Jerome Park Reservoir. An illustrated article reviewing briefly the Croton reservoirs and describing the new reservoir at Jerome Park. 1800 w. Sci Am—May 13, 1905. No. 69485.

The Cross River Reservoir for the Water Supply of New York City. Describes briefly this new reservoir of 10 billion gallons capacity, to be built to store the surplus water of an easterly tributary of the Croton River. Ills. 1100 w. Eng Rec—May 20, 1905. No. 69808.

Sanitation.

Sanitary Engineering Work in a Large Residence. Illustrated description of the design of the plumbing, heating, ventilation, and lighting systems for a house at Chestnut Hill, Mass. 2000 w. Eng Rec—April 29, 1905. No. 69322.

Tanks.

How to Set Up Wood Stave Tanks. R. Stuart Browne. An interesting description of methods of building and tearing down wood stave tanks, taken from advance sheets of a new catalogue of the Redwood Mfg. Co. 1300 w. Min & Sci Pr—April 22, 1905. No. 69292.

WATERWAYS AND HARBORS.

Anchor Ice.

Formation of Anchor Ice, and Precise Temperature Measurements. Dr. Howard T. Barnes. Investigations into the formation of slush or frazil ice in streams, and its relation to the temperature of the water. The apparatus for measuring the temperatures of the streams is very fully discussed. 7500 w. Trans Am Soc Mech Engrs—No. 070, June, 1905. No. 69557 C.

The Elevators at the St. Louis Water Works. E. E. Wall. An account of the trouble caused by anchor or needle ice in the wet well at the Chain of Rocks, and the elevators built to remove it. Ills. 700 w. Eng Rec—May 20, 1905. No. 69810.

Canals.

A New Baltic Black Sea Canal Scheme. Briefly outlines the plan suggested by M. W. von Rukteschell, a Russian engineer. It is called the Riga-Cherson Canal scheme, and utilizes the Duna and Dnieper rivers with a connecting canal. 900 w. Engng—May 12, 1905. No. 69832 A.

Channels.

Natural and Artificial Forms of River Channels (Natürliche und Künstliche Formen des Flussgerinnes). Valentin Lapaine. An examination of the natural tendency of streams to flow in curved channels, suggesting that artificial controlling works should be designed accordingly. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—April 22, 1905. No. 69760 D.

Dams.

See Civil Engineering, Construction.

Docks.

Reconstruction of Singapore Docks and Wharves. Describes the proposed reconstruction of wharves and extension of dock accommodations, and other improvements under consideration. 5000 w. Far East Rev—March, 1905. No. 69465 D.

Dredge.

The Submerged Jet Dredge. H. L. Lewis. Description of J. T. Johnson's patent, giving plan of pressure pipes and floats. 900 w. Min Jour—April 29, 1905. No. 69455 A.

Dry Dock.

The Construction of a Timber Dry Dock. G. B. Ashcroft. Plates and detailed description of a dry-dock in Baltimore which has been in satisfactory operation since 1901. Ills. 8000 w. Can Soc of Civ Engrs—April 20, 1905. No. 69644 D.

Flow.

Records of Blow at Current Meter Gaging Stations When the Streams Are Subject to Ice. F. H. Tillinghast. A study of the flow of water under ice, giving tabulated measurements. 1500 w. Eng News—May 11, 1905. No. 69496.

The Mean Velocity in Natural and Artificial Channels (Die Mittlere Profilgeschwindigkeit in Natürlichen und Künstlichen Gerinnen). Johann Hermanek. An examination of the various formulas for the flow of water, with especial reference to the determination of the coefficients. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 21, 1905. No. 69728 D.

Flumes.

Flumes for Transporting Logs, Lumber, and Sugar Cane. Photographs and description of flume construction. 3000 w. Eng News—May 18, 1905. No. 69629.

Harbor Improvements.

Improvement of the Harbor of Manila. An illustrated description of a public work nearing completion. 2800 w. Far East Rev—March, 1905. No. 69464 D.

Pier and Bulkhead Construction in New York Harbor. Sidney W. Hoag. Abstract of a paper before the Munic. Engrs. of N. Y. A review of the methods and work during the past thirty years of the N. Y. Dock Dept. in the construction of wharfage structures. Ills. 2500 w. Eng News—May 18, 1905. No. 69630.

Port Colborne Harbor Works. J. M. Hogan. Illustrates and describes important works comprising new docks, excavation of channels and two large breakwaters to the east and west of this port, situated at the Lake Erie end of the Welland Canal. 3500 w. Can Soc of Civ Engrs—Feb., 1905. No. 69645 C.

Notes on the Improvement of River and Harbor Outlets in the United States. D. A. Watt. A study of the conditions of several localities before and after improvement, giving a summary of the principles corroborated and the generally accepted theories. Ills. and maps. 6500 w. Pro Am Soc of Civ Engrs—May, 1905. No. 69879 E.

The Manila Harbor Improvements. Brief illustrated account of the dredging work and breakwater construction. 1000 w. Eng Rec—May 27, 1905. No. 69908.

Lighthouses.

See Electrical Engineering, Illumination.

Protection Works.

The Efficiency of the Protection Works of the Salzkammergut Lakes (Die Verwertung des Retentionsvermögens der Salzkammergut Seen). Ernst Lauda. A discussion of the regulation works of the Traun, and the lakes in the Salzkammergut district of Styria, Austria. Two articles. 1000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—April 28, May 5, 1905. No. 69729 each D.

River Regulation.

Correction of the River Drave by Sunken Trees (Ueber eine Anwendung von Sinkbaumen am Drauflusse). Anton Weber. A description of the method of sinking weighted trees to form a correcting embankment on the Drave, near Pettau, in Styria. 2000 w. 1 plate.

Oesterr Wochenschr f d Oeffent Baudienst—April 29, 1905. No. 69761 D.

The Reclamation of One Million Acres of Swamp Land in California. Rufus P. Jennings. States the conditions of the Sacramento River and the proposed plan recommended by a Commission of engineers for concentrating the flow. Map and Ills. 2000 w. Eng Rec—May 6, 1905. No. 69447.

Victoria Falls.

The Physical History of the Victoria Falls. Abstract of a paper by A. J. C. Molyneaux in the *Geographical Journal.* Claims the combination of cañon, gorge, chasm, and falls is due to erosion, and the constant reducing action of the Zambesi River. Ills. 900 w. Nature—April 27, 1905. No. 69460 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The Practical Management of Maintenance and Operation of a Telephone Exchange. C. E. Stinson. Read before the Ohio Ind. Telephone Assn. Discusses details of importance in successfully conducting an exchange of 9,000 telephones. 2500 w. Elec Rev, N Y—April 29, 1905. No. 69277.

Printing Telegraph.

Barclay's Printing Telegraph. Illustrated description of the apparatus invented by John C. Barclay, as embodied in the patent specification. 1800 w. Sci Am Sup—May 27, 1905. No. 69871.

Space Telegraphy.

Regulations for Space Telegraphy in the German Empire (Regelung der Funkentelegraphie im Deutschen Reich). A reprint of the official regulations, in force since April 1, 1905. 1500 w. Elektrotech Zeitschr—April 27, 1905. No. 69770 B.

The Massie Wireless Telegraph System. A. Frederick Collins. Illustrated detailed description. 1800 w. Sci Am Sup—May 20, 1905. No. 69624.

Wireless Telegraphy in Germany. A. Frederick Collins. Information from a pamphlet written by Count Arco in regard to the System Telefunken, as the combined systems are called. 2800 w. Elec Wld & Engr—May 27, 1905. No. 69918.

Space Telephony.

High Frequency Currents and Space Telephony (Les Courants de Haute Fréquence et la Téléphonie sans Fil). L. Ancel. An examination of the phenomena of high frequency currents, and a discussion of the Ruhmer system of telephony by the action of light on selenium. 4000 w. Mem Soc Ing Civ de France—Feb., 1905. No. 69785 G.

Telephone Cables.

Comparative Investigations of System Cables (Vergleichende Untersuchungen an Systemkabeln). Dr. W. Schuler. An examination of the special cables used in the interior of a telephone exchange, as distinguished from line cables. 7000 w. Elektrotech Zeitschr—May 4, 1905. No. 69771 B.

Telephones.

British-Made Telephones. An illustrated account of a visit to the General Electric Company's Salford works. 3000 w. Elec Engr, Lond—May 12, 1905. No. 69822 A.

Telephony.

The Telephone System of To-day. C. J. H. Woodbury. Abstract of a paper before the Brooklyn Inst. of Arts & Sciences. An explanation of the latest type of the telephone system, discussing operation, rates, &c. 4500 w. Elec Rev, N Y—May 13, 1905. No. 69528.

DISTRIBUTION.

Accumulators.

Switch Connections for Storage Battery Plants (Ueber Leitungen Sparende Zellenschalter für Akkumulatorenbatterien). C. Liebenow. Describing switch connections for a storage battery by which the cells may be thrown into service in various combinations. 2500 w. Elektrotech Zeitschr—May 4, 1904. No. 69773 B.

Cables.

Types of Electric Cables: Hints on Their Manipulation. J. H. C. Brooking. Notes applying more particularly to paper-insulated cables, and the troubles when used under bad conditions. 2800 w. Prac Engr—May 5, 1905. No. 69582 A.

Conduit System.

Underground Electrical Conduit System in New Orleans. Illustrates and describes this work nearing completion, which required unusual care because of the character of the soil, the drainage system and climatic conditions. 1500 w. Elec Wld & Engr—May 13, 1905. No. 69566.

Current Losses.

Theft of Current: How to Detect, Prosecute and Prevent. J. H. Hallberg. A description of methods successfully employed, with references to specific cases of theft current. Ills. 2200 w. Elec Wld & Engr—April 29, 1905. Serial. 1st part. No. 69315.

Fuses.

Low-Tension Fuses. Prof. Alfred Schwartz and W. H. N. James. Abstract of a paper on "Low Tension Thermal Cut-outs," read before the Manchester Loc. Sec. of the Inst. of Elec. Engrs. A report of experimental investigations. 5000 w. Elect'n, Lond—April 21, 1905. No. 69333 A.

Relays.

Time-Limit Relays. George F. Chellis. Discusses the operation of various types. 3200 w. Am Inst of Elec Engrs—May, 1905. No. 69688 D.

Switches.

Automatic High Pressure Switches (Automatischer Hochspannungsschalter). Max Vogelsang. Describing a form of oil insulated switch adapted for automatic parallel operation. 4000 w. Elektrotech Zeitschr—May 11, 1905. No. 69775 B.

ELECTRO-CHEMISTRY.

Alkalies.

Progress in the Electrolytic Alkali and Bleach Industry. John B. C. Kershaw. Notes in regard to the position of the industry in the various countries. 1800 w. Elec Rev, N Y—May 27, 1905. No. 69901.

Battery.

A Novel Thermo-Electric Battery. Emile Guarini. Illustration, with brief description, of a battery called a "thermotor," made in Germany. 500 w. Sci Am Sup—May 6, 1905. No. 69393.

Electric Furnaces.

The Present Status of Electric Furnace Working. Charles F. Burgess. States some of its advantages, illustrating and describing various forms, furnace construction, &c., and discussing its efficiency. General discussion. 10500 w. Jour W Soc of Engrs—April, 1905. No. 69685 D.

Electric Smelting.

Operative Results of Some Electric Iron and Steel Processes (Betriebsergebnisse einiger Elektrischer Eisen und Stahlprozesse). Dr. B. Neumann. Data and results of work with the Héroult, Keller, Stassano, and Kjellin furnaces. 3500 w. Stahl und Eisen—May 1, 1905. No. 69741 D.

The Electrometallurgy of Iron and Steel (Beiträge zur Elektrometallurgie des Eisens und Stahls). Dr. Albert Neuburger. Discussing the practical working of the processes of Harmet, Girod, Neuburger-Minet, Ruthenburg, and Conley. 3000 w. Glückauf—May 13, 1905. No. 69751 D.

Nitric Acid.

The Electrical Production of Nitric Acid—A Review. H. R. Carveth and C. L. Rand. A review of methods of investigators and of work up to the present time. 4000 w. Sib Jour of Engng—May, 1905. No. 69659 C.

ELECTRO-PHYSICS.

Conductivity.

The Effect of Impurities on the Electrical Conductivity of Copper. Lawrence Addicks. Gives results of experiments made with the idea of determining the amount of various elements which would lower the conductivity 3 or 4 per cent. 1500 w. Am Inst of Min Engrs—Feb., 1905. No. 69846.

Insulation.

Considerations Relating to the Design of the Armature Slot Insulation in High Voltage Alternating Current Generators. H. M. Hobart. Investigations as regards the thickness of the slot insulation from the armature conductors to the iron core are discussed in the present article. 900 w. Elec Rev, Lond—April 28, 1905. Serial. 1st part. No. 69571 A.

Magnetism.

Notes on the Effect of Electric Oscillations on Magnetism. L. H. Walter. Notes relating to magnetic detectors, based upon experimental work. Reference is also made to work of other investigators. 1800 w. Elect'n, Lond—May 5, 1905. No. 69500 A.

Magnets.

A Comparison of Common Methods of Magnet Coil Winding. Charles R. Underhill. 1400 w. Am Elect'n—May, 1905. No. 69359.

The Law of the Plunger Electromagnet. Charles R. Underhill. Showing that the formula given by Prof. Sylvanus P. Thompson is not strictly correct when applied to this type. 1000 w. Elec Wld & Engr—May 20, 1905. No. 69672.

Radioactivity.

Radium and Radioactivity (Le Radium et la Radioactivité). Paul Besson. A description of the preparation of radium salts, and a review of the investigations which have been made during the past two years. 10000 w. Mem Soc Ing Civ de France—Feb., 1905. No. 69784 G.

Rotation.

An Investigation of Rotations Produced by Current from a Single-Phase Alternator. Arthur Curtis Scott. Correlation of experimental data, facts and theories, with verification of principles evolved, and a general study of the subject. Ills. 30000 w. Bul Univ of Wis—No. 102—Sept., 1904. No. 69615 D.

Solenoids.

Calculation of Pull Due to Solenoids. Charles R. Underhill. Gives data obtained by tests, and applies these data to practical design. 1800 w. Elec Wld & Engr—May 13, 1905. No. 69567.

The Practical Design of the Solenoid. Charles R. Underhill. Discusses the law controlling the action when a current is passed through the winding. 1200 w. Elec Wld & Engr—April 29, 1905. No. 69316.

Sparking.

Limits of Injurious Sparking in Direct-Current Commutation. Thorburn Reid. Considers in detail what happens to a commutator segment while the machine is running, and aims to prove that the question of sparking is simply a question of the temperature of the segment while it is under the brush. 7200 w. Am Inst of Elec Engrs—May, 1905. No. 69691 D.

The Influence of the Ionized Medium and the Resistance upon Sparks over Wide Gaps (Beeinflussung Grosser Funkenstrecken durch Ionisierende Körper und der Uebergangswiderstand). Dr. W. Voege. An examination of the law governing electrical discharges, with especial reference to the influence of the intervening medium. 3000 w. Elektrotech Zeitschr—April 20, 1905. No. 69765 B.

GENERATING STATIONS.

Dynamo.

A New Dynamo. From *Elektrotechnische Zeitschrift*. Illustrates and describes a dynamo designed by Prof. E. Rosenberg for the lighting of railway carriages. 2400 w. Elec Engr, Lond—April 28, 1905. No. 69469 A.

Dynamo Testing.

See Electrical Engineering, Measurement.

Erection.

Installing Electric Machinery. Norman G. Meade. Gives a few practical hints for erecting such apparatus, with illustrations. Power—May, 1905. No. 69420 C.

Hydro-Electric.

A Norwegian Hydro-Electric Plant. T. Norberg Schulz. Gives calculations made with the intention of solving the economical problems raised in connection with the combined operation of an older steam station and newer water power plant. 1000 w. Elec Wld & Engr—April 29, 1905. No. 69314.

Hydraulic Station, La Goule, Switzerland. F. M. Bryan. Illustrated description of a power transmission plant having many unusual features. It was designed to supply many small motors over quite an extensive territory. Also editorial. 2800 w. Elec Wld & Engr—May 20, 1905. No. 69671.

The Hydraulic Plant of the Puget Sound Power Company. Edwin H. Warner. Illustrated description of this power plant in Washington, which will supply power to Seattle, Tacoma, and interurban railways. 6000 w. Pro Am Soc of Civ Engrs—May, 1905. No. 69878 E.

The Hydraulic Power Works on the River Glommen, Norway. An interesting account of one of the largest hydraulic power works in Europe for the generation of electrical energy. Ills. 1300 w. Sci Am Sup—May 20, 1905. Serial. 1st part. No. 69623.

The Necaxa Plant of the Mexican Light & Power Co. J. L. Bothwell. Short description of a plant of unusual engineering interest. 1200 w. Eng Rec—May 20, 1905. No. 69811.

The New Hydro-Electric Power Plant of Cornell University. W. W. Churchill. An illustrated article giving a full account of this work and describing the design and construction. 3500 w. Eng Rec—May 20, 1905. No. 69804.

The Supply of Electric Energy to Burgos (Transporte de Energia Electrica á Burgos). A description of the proposed hydro-electric plant on the Ebro, 50 kilometres from Burgos, Spain, for the generation and transmission of 1,100 h. p. for power and lighting. Serial. Part I. 7000 w. Revista de Obras Publicas—April 27, 1905. No. 69787 D.

Isolated Plant.

Power Plant of the First National Bank Building, Chicago. An illustrated detailed description of a fine isolated plant that supplies power for a 17-story building. 3800 w. Engr, U S A—May 1, 1905. No. 69361 C.

The Power Installation at the Whittall Mills. Howard S. Knowlton. Illustrates and describes an interesting steam and electric installation recently placed in operation in some carpet mills in Worcester, Mass. 2500 w. Eng Rec—May 6, 1905. No. 69448.

Municipal Plant.

Municipal Light and Power in Tacoma, Wash. Howard Joslyn. Abstract of a paper read before the Pacific N. W. Soc. of Engrs. A full account of cost and earnings since the purchase of the plant in 1893, and the arrangements that have made possible the exceedingly low rates of the past two years. 2800 w. Elec Rev, N Y—May 13, 1905. No. 69529.

Operation.

Incidents in the Operation of a Large Power Plant and Distribution System. H. G. Stott. Gives incidents which occurred in the 74th St. plant and transmission system of the Interborough Rapid Transit Co. of New York City. 1500 w. Elec Club Jour—May, 1905. No. 69663.

Reserve.

Duplication of Electrical Apparatus to Secure Reliability of Service. H. W. Buck. Discusses the question of the proper reserve in an electrical installation, considering the several classes of apparatus and their liability to injury. 2500 w. Am Inst of Elec Engrs—May, 1905. No. 69689 D.

Santa Cruz, Cal.

Electricity in the "City of the Holy Cross." An illustrated article describing the electrical situation, the service being divided among six different companies. 4400 w. Jour of Elec—May, 1905. No. 69564 C.

Turbo-Alternator.

2,700 Horse-Power Turbo-Alternator. Illustrated description of a powerful combined set made in Switzerland. 2000 w. Engr, Lond—April 21, 1905. No. 69342 A.

LIGHTING.

Decoration.

Decorative Insulating Beads for Uninsulated Electric Light Wires. Illustrates and describes a system in which beads of cut and polished glass are strung on naked wires of copper, stating the advantages. 900 w. Sci Am Sup—May 20, 1905. No. 69625.

Fittings.

Fittings. Harold Watson. Abstract of a paper read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. An illustrated article considering some of the factors in the evolution of the design of electric fittings, and some of the conditions designers have to fulfil. 3300 w. Elect'n, Lond—May 12, 1905. No. 69821 A.

Illumination.

Lighting an Assembly Room. W. H. Wakeman. Illustrated description of a plan adopted for controlling lights in the assembly room of a large school building. 700 w. Elec, N Y—May 17, 1905. Serial. 1st part. No. 69605.

Lamps.

Is the Carbon Filament Lamp Doomed? E. Leavenworth Elliott. A brief review of the carbon filament lamp, discussing the merits and demerits of the lamps aiming to improve upon it. 3500 w. Cent Sta—May, 1905. No. 69484.

New American Lamps (Neue Amerikanische Lampen). Clarence Feldmann. Discussing especially the mercury vapor lamp, and the American forms of the Nernst lamp. 2000 w. Elektrotech Zeitschr—May 11, 1905. No. 69776 B.

Lighthouses.

The Electric Illumination of Lighthouses. Editorial discussion of English and French practice, and the suitability of electric illumination. 1200 w. Engr, Lond—May 5, 1905. No. 69600 A.

Nernst.

Street Lighting in New England. Illustrates and describes the successful adaptation of Nernst lamps at West Hartford, Conn. 1000 w. Elec Rev, N Y—May 20, 1905. No. 69670.

Paris.

The Electric Lighting Situation in Paris. Begins a review of the report of a technical commission appointed to investigate the problem. Map. 1000 w. Elec Wld & Engr—May 13, 1905. Serial. 1st part. No. 69568.

Photometry.

See Electrical Engineering, Measurement.

Tantalum.

Measurements upon the Tantalum Lamp (Messungen an Tantallampen). Egon Siedek. With diagrams of comparative measurements with the carbon filament showing the superiority of the tantalum lamp. 1000 w. Zeitschr f Elektrotechnik—May 7, 1905. No. 69780 D.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

Alternator Curves.

The Analysis of Alternator Curves. Charles F. Smith. Explains the method of curve analysis, illustrating by example. 1700 w. Mech Engr—May 13, 1905. Serial. 1st part. No. 69819 A.

Dynamo Testing.

A New Method of Testing Alternators (Eine Neue Methode zur Prüfung von Wechselstromgeneratoren). H. M. Hobart and F. Punga. The losses are separated into friction losses, heating, and iron losses. 2000 w. Elektrotech Zeitschr—May 11, 1905. No. 69774 B.

Some Advantages of Liberal Design. B. G. Lamme. Comments upon the "Test of a 5,000 Kw. Alternator." 800 w. Elec Club Jour—May, 1905. No. 69664.

Test of a 5,000 Kw. Alternator. L. L. Gaillard. An illustrated general description of the series of tests made on each of the alternators installed in the 74th St station of the Interborough Rapid Transit Co., of New York City. 1800 w. Elec Club Jour—May, 1905. No. 69662.

Harmonic Analysis.

Harmonic Analysis Reduced to Simplicity. Silvanus P. Thompson. A description of a new rapid method of harmonic analysis. 2800 w. Elect'n, Lond—May 5, 1905. No. 69588 A.

Magnetic Testing.

Comparative Magnetic Researches with the Iron-Testing Apparatus of Epstein, Möllinger, and Richter (Vergleichende Magnetische Untersuchungen mit den Eisenprüfapparaten von Epstein, Möllinger und Richter). E. Gumlich and P. Rose. A very full account of investigations upon hysteresis conducted at the Reichsanstalt. 8000 w. Elektrotech Zeitschr—April 27, 1905. No. 69768 B.

Mirror Instruments.

An Extension of the Poggendorff Mirror-Reading Method (Eine Erweiterung der Poggendorffschen Spiegelablesungsmethode). E. Preuss. Describing a method of multiplying the movement of the spot of light, for galvanometers and similar reflecting instruments. 2000 w. Elektrotech Zeitschr—April 27, 1905. No. 69769 B.

Motor Testing.

The Eddy Current Brake for Testing Motors. D. K. Morris, and G. A. Lister. Abstract of a paper read before the Birmingham Sec. of the Inst. of Elec. Engrs. States the advantages of eddy current brakes, and describes a new design. Ills. 1800 w. Mech Engr—April 29, 1905. No. 69466 A.

Oscillograph.

A Convenient Form of Oscillograph. F. A. Laws. Illustrated description of a form of oscillograph which has been developed in the Massachusetts Institute of Technology to meet the requirements of students in the laboratory. 1800 w. Elec Wld & Engr—May 6, 1905. No. 69427.

Photometry.

Photometric Tests of Street Lamps in Teddington. Clifford C. Paterson. Gives results of some photometric measurements of street lamps, with data concerning the amount of gas and electricity taken by the lamps under test. 700 w. Elect'n, Lond—April 28, 1905. No. 69473 A.

Synchronizer.

The Automatic Synchronizer. Norman G. Meade. Illustrates and describes the instrument and its operation, and also other synchronizing devices. 1700 w. Elec Club Jour—May, 1905. No. 69665.

Wattmeter.

The Westinghouse Direct-Current Integrating Wattmeter. Illustrations with description. 600 w. Sci Am Sup—May 13, 1905. No. 69490.

MOTORS.

Alternating Current.

The Alternating-Current Series Motor. F. Creedy. An account of some investigations carried out at the Central Technical College between March and July, 1904, which are intended to show the effect, on the performance of the motor, of varying the elements of the design. 12800 w. Inst of Elec Engrs—April 13, 1905. No. 69331 D.

Commutation.

Commutation in a Four-Pole Motor. J. K. Catterson-Smith. A report of investigations with a view to recording by means of the oscillograph the actual manner in which the current is reversed during commutation, giving results. 2000 w. Inst of Elec Engrs—March 15, 1905. No. 69330 D.

Induction Motors.

Notes on the Theory and Testing of the Polyphase Induction Motor. W. Rogers. Describes the polyphase induction motor and considers some methods of starting and regulating the speed, in the present number. 3500 w. Elec Engr, Lond—May 12, 1905. Serial. 1st part. No. 69824 A.

Motor Controllers.

Automatic Controller for Induction Motors. William Main. Illustrates and describes a motor controller for a three-phase sixty-cycle General Electric induction motor. 800 w. Am Mach—Vol. 28, No. 20. No. 69617.

The Design of Controllers with Shifting Contacts (Ueber den Entwurf von Kontrollern mit Wanderkontakten). Robert Edler. Describing the design of special forms of controllers for use with electric cranes. 3000 w. Zeitschr f Elektrotechnik—May 7, 1905. No. 69779 D.

Motor Testing.

See Electrical Engineering, Measurement.

Single Phase.

The Computations for Single-Phase Commutator Motors (Zur Berechnung Einphasiger Kommutatormotoren). J. K. Sumec. A mathematical examination of the theory of the various forms of single-phase motors, with applications to practical details of design. 6000 w. Zeitschr f Elektrotechnik—April 23, 1905. No. 69777 D.

TRANSMISSION.

High Pressure.

Discussion on "Line Construction for High-Pressure Electric Railroads," and "High-Pressure Line Construction for Alternating-Current Railways." Discussion on papers of Mr. Varney and Mr. Damon. Ills. 5600 w. Am Inst of Elec Engrs—May, 1905. No. 69690 D.

Line Losses.

Line Effects Due to a Moving Load. Carl P. Nachod. An analytical study of the distribution of current potential and energy lost in circuits supplying power from two points to a locomotive traversing the distance between them. Also editorial. 900 w. Elec Wld & Engr—April 29, 1905. No. 69317.

Poles.

The Deflection of Pole Supports for Line Wires (Durchbiegung von Leitungsmasten). K. Otto. Discussing especially the stiffness of latticed poles and masts and their resistance to deflection; deriving a formula for taper masts. 1500 w. Elektrotech Zeitschr—April 20, 1905. No. 69764 B.

Relays.

Relays for Direct and Alternating Current Circuits. An illustrated description of a series of direct and alternating current relays manufactured by the British Westinghouse Company. 1700 w. Elec Engr, Lond—May 5, 1905. No. 69586 A.

MISCELLANY.

Exhibition.

Report upon the Exhibition of the Electrotechnical Society (Bericht über die Ausstellung des Electrotechnischen Vereins). F. Breisig. A fully illustrated description of the principal exhibits of the electrical exposition held on the twenty-fifth anniversary of the society. 25000 w. Elektrotech Zeitschr—April 20, 1905. No. 69766 B.

Hippodrome.

The Application of Electricity in the New York Hippodrome. An illustrated article describing some of the novel features of the stage and the applications made of electricity for handling scenery, regulating lights, &c., in this large amusement building. 2500 w. Elec Rev, N Y—April 29, 1905. No. 69276.

Lightning.

Report of the Lightning Research Committee. Sir Oliver Lodge gives a preface explaining the report, which follows. 6300 w. Jour Ry Inst of Brit Archts—May 6, 1905. No. 69899 D.

INDUSTRIAL ECONOMY

Address.

Presidential Address at the Annual Meeting in London, of the Iron & Steel Institute. R. A. Hadfield. Reviews the history of the manufacture of iron and steel. 21000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69883 A.

Presidential Address Delivered Before the Iron and Steel Institute. R. A. Hadfield. Abstract of address delivered May 11, 1905. A history of iron and steel manufacture. 8000 w. Engng—May 12, 1905. No. 69831 A.

Presidential Address to the Institution of Mechanical Engineers. Edward P. Martin. On some of the improvements applied to the manufacture of iron and steel which have greatly increased the output and reduced the cost of production. 6500 w. Engr, Lond—April 21, 1905. No. 69348 A.

Canada.

The Canadian Dominion of To-day: Its Industries, Commerce, Railways and Waterways. An interesting general review. Ills. 19500 w. Ir & Coal Trds Rev—May 12, 1905. No. 69894 A.

Commerce.

The Commerce of the United States. Reviews a recent report issued by the Treasury Department at Washington on the foreign commerce and home trade, showing the rapid growth of industries. 2300 w. Engng—April 28, 1905. No. 69475 A.

Education.

American Technical Laboratories (Amerikanische Technische Laboratorien). A. Gramberg. A description from a German viewpoint of the mechanical laboratories of the principal engineering schools in America. 4500 w. Zeitschr d Ver Deutscher Ing—April 22, 1905. No. 69705 D.

The Function of Laboratory Courses in the Curriculum of Engineering Schools. Charles Edward Lucke. Discusses the methods of laboratory instruction, the aim, &c. 4700 w. Trans Am Soc of Mech Engrs, No. 066—June, 1905. No. 69553 C.

Exports.

Engineering Exports of Britain, Germany and the United States. W. Pollard Digby. A review of the general industrial situation, showing the trend of trade supremacy. 3000 w. Engineering Magazine—June, 1905. No. 69791 B.

Labor.

Labor, Foreign Commerce, and Railroad Questions. D. M. Parry. Extracts from the Presidential Address at the convention of the Nat. Assn. of Mfrs. Discusses the questions of labor, interstate commerce legislation, rates, &c. 5000 w. Ir Age—May 18, 1905. No. 69610.

MARINE AND NAVAL ENGINEERING

Arctic Ship.

Peary's Arctic Exploration Ship. An illustrated detailed description of the "Roosevelt." 5400 w. Marine Rev—May 4, 1905. No. 69438.

Peary's Latest Arctic Ship, the Roosevelt. Illustrated description of this vessel, giving design plans. It is technically described as a "three-masted, fore-and-aft, schooner-rigged steam vessel, with auxiliary sail power." It has features of unusual interest to meet the severe requirements. 2000 w. Marine Engng—May, 1905. No. 69297 C.

Armor Plate.

Armor Plate and Projectile Trials. Gives illustrations and report of results of trials to show the resistance qualities of the latest type of armor forming the belt of the Japanese Battleship No. 1, now being built. 1200 w. Engng—April 28, 1905. No. 69477 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

Car-Ferry.

Car-Ferry Steamer "Detroit"; Michigan Central R. R. Illustrates and describes a four-screw car-ferry steamer of exceptional size and power, designed to serve as an ice-breaker and to maintain service between Detroit, Mich., and Windsor, Ont. 1000 w. Eng News—May 4, 1905. No. 69363.

Cruisers.

The Japanese Cruisers "Kasuga" and "Nisshin." Col. N. Soliani. A very complete illustrated description of details of construction. 5000 w. Engng—April 21, 1905. No. 69335 A.

The Machinery of the Armored Cruisers North Carolina and Montana. Illustrated description of the machinery. 1700 w. Marine Engng—May, 1905. No. 69296 C.

The Steam Trials of H. M. SS. "Antrim" and "Devonshire." Illustrations, report of trials, and remarks on features of interest. 1500 w. Engng—April 28, 1905. No. 69480 A.

Destroyers.

Some Notes and Recollections of Destroyer Trials. Illustrates a number of these vessels, and gives an account of the preparation for the trials, the work of the men during the trial, &c. 2800 w. Marine Rev—May 11, 1905. No. 69532.

The Development of the Torpedo-Boat Destroyer. W. J. Harding. Abstract of a paper read before the Inst. of Marine Engrs. An interesting review, with illustrations. 6900 w. Naut Gaz—May 25, 1905. No. 69897.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Gyrostats.

Gyrostats and Gyrostatic Action. Prof. Andrew Gray. Describes examples of gyrostatic action, and discusses the fundamental principles and their explanation, and related subjects, considering various devices and the action of steamers in which the main propelling engines are of the steam turbine type. 15000 w. Ills. Trans Inst of Engrs & Shipbldrs in Scotland—March 21, 1905. No. 69640 D.

Some Notes on the Effects Likely to Be Produced by the Gyroscopic Action of Steam Turbines on Board Vessels Pitching in a Sea. J. Blacklock Henderson. An examination of possible effects. 1200 w. Trans Inst of Engrs & Shipbldrs in Scotland—March 21, 1905. No. 69639 D.

Ice Breaker.

Ice Breaker for the Delaware. Illustrated description of vessel to be built for the city of Philadelphia for use on the Delaware. 1800 w. Marine Rev—May 4, 1905. No. 69439.

Launches.

A Novel Power Launch for Clearing Weed-Infested Waterways. Illustrates and describes a motor launch equipped with a novel cutting appliance—the Saunderson gasoline power weed - cutting launch. 900 w. Sci Am—May 27, 1905. No. 69868.

French Launches and Launch Engines of 1905. W. P. Stephens. An illustrated article describing interesting features, and types, and commenting on the remarkable development of the launch industry. 2000 w. Rudder—May, 1905. No. 69373 C.

Marine Designs.

Factors of Safety in Marine Designs. A. E. Seaton. Read before the Inst. of Naval Archts. Discusses the margins now imposed, especially on boilers, and the evils and cost of the present way of insuring satisfactory performance. 4000 w. Engng—April 28, 1905. No. 69482 A.

Model Experiments.

Model Experiments on Hollow *versus* Straight Lines. R. E. Froude. Read before the Inst. of Naval Archts. Describes the special apparatus and mode of experiment employed. 5800 w. Engng—April 21, 1905. No. 69339 A.

Motor Boats.

Light-Draft Gasolene-Propelled Western River Boat. Brief illustrated description of the sternwheeler City of Fort Pierre, operating on the Upper Missouri River. It is equipped with an 80 h. p. Otto engine. 500 w. Naut Gaz—May 4, 1905. No. 69437.

Motor Boats at Monaco. Begins a review of the racing boats, discussing their design and construction. 2200 w. Engr, Lond—April 21, 1905. Serial. 1st part. No. 69345 A.

Notes on Power-Boat Design. N. L. Skene. A discussion of some of the important features of their design, such as form, especially of the underbody, outlining a practical method. 2200 w. Rudder —May, 1905. No. 69375 C.

Paddle Steamers.

Thames Paddle-Steamer for the London County Council. Brief illustrated description of one of two recently launched steel vessels. 300 w. Engng—May 5, 1905. No. 69594 A.

Repairs.

Electrical Repairs at Sea. Describes some of the methods of testing and makeshifts resorted to where conditions are often very different from those on land, and supplies not always available. 2400 w. Elec Rev, Lond—April 28, 1905. No. 69470 A.

Resistance.

The Effect of Acceleration on Ship Resistance. C. E. Stromeyer. Read before the Inst. of Naval Archts. Notes on Beaufoy's experiments, with explanation of an attempt to obtain resistance curves of ships and applying the method to Beaufoy's work. 2000 w. Engng—April 21, 1905. No. 69340 A.

Russian Fleet.

The Russian Volunteer Fleet. Herbert Rowell. Read before the Inst. of Naval Archts. The present article explains the objects of the Russian Volunteer Fleet Assn. and describes the ships. Ills. 3500 w. Engng—April 28, 1905. Serial. 1st part. No. 69481 A.

Shipbuilding.

Steel Ship Building Berths. F. H. Rudolph. Illustrates and describes the steel ship-building slips at Vulcan plant at Stettin. 1600 w. Marine Rev—May 4, 1905. No. 69440.

Steamer.

Twin-Screw Passenger and Cargo Steamer. Illustrations and description of the shallow draught steamer "Naparima," and her machinery. This vessel is to be run in conjunction with the Trinidad Government Railways. 1600 w. Engng—April 28, 1905. No. 69476 A.

Steering.

Electric Steering. George E. Walsh. Information concerning the development of steering devices to be operated by electricity, and the fields where it has been successfully applied. 2000 w. Marine Engng—May, 1905. No. 69301 C.

Training Ship.

The Training of Sailors. Illustrated description of a recently launched vessel specially designed for the training of boys for the naval and merchant marine. 1700 w. Engng—April 21, 1905. No. 69337 A.

Turkish Fleet.

The Reconstruction of the Turkish Fleet. Dagnino Attilio. Some information in regard to the rebuilding of the largest ship in the Turkish navy, the *Mess'oudijeh*, and the construction of torpedo boats. Ills. 1400 w. Marine Engng —May, 1905. No. 69300 C.

War Ships.

The Principle of the Cellular Construction of Ships (Note sur le Principe des Navires à Flottaison Cellulaire). M. Bertin. A review of the extension of the applications of the cellular system since the writer's first communication to the Academy in 1884. 1800 w. Comptes Rendus—April 17, 1905. No. 69723 D.

Yachts.

The Stability Calculation for a Modern Sailing Yacht. Gives method, describing the operations. Diagrams. 2000 w. Marine Engng—May, 1905. No. 69298 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

The Problem of Air Cooling. F. Reaugh. Considers some of the difficulties in the way of air-cooling and some possible ways of surmounting them. 1800 w. Automobile—April 20, 1905. No. 69273.

Car Control.

Car Control by Spark and Throttle. Considers the various manipulations best suited to different types of cars. 2500 w. Automobiles—April 20, 1905. No. 69274.

Cupelle.

The Cupelle Petrol Cars. An illustrated article giving particulars of these cars. 1100 w. Auto Jour—May 6, 1905. No. 69579 A.

Drives.

Points on Propeller Shaft Drive. Rene M. Petard. Gives some details concerning chain driven, and Cardan shaft transmission, showing that the latter can be made as flexible as the chain. 1300 w. Automobile—May 13, 1905. No. 69530.

Dust Laying.

Dust-Laying Experiments at Liverpool. A. Lyle Rathbone. From a paper read before the Liverpool Self-propelled Traffic Assn. On the experiments of a temporary and also of a more or less permanent character, made in Liverpool during the past three or four years. 2400 w. Autocar—April 29, 1905. No. 69463 A.

Industrial Vehicles.

Motor Vehicles for Industrial Use on Streets without Tracks (Motorisch Betriebene Fahrzeuge auf Schienenlosen Strassen für Industrielle Zwecke). Karl Rubricius. Illustrating numerous types of industrial vehicles with data concerning their performance. 3500 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—May 6, 1905. No. 69763 D.

Five-Wheeled.

A Novel Five-Wheeled Automobile. Illustrates and describes a vehicle propelled by a drum-like fifth wheel under its center. 700 w. Sci Am—May 13, 1905. No. 69488.

Garage.

New Electric Garage in Denver. Illustrated description of a new garage for the handling and storage of electric automobiles. 900 w. Elec Wld & Engr—May 27, 1905. No. 69919.

Locomotion.

Some Problems of the Automobile. Frederic Remsen Hutton. A simple discussion of fundamental principles of car and motor design in locomotion on the highways. 1800 w. Automobile—May 6, 1905. Serial. 1st part. No. 69394.

Petrol Cars.

Petrol Motor Cars. Frank Little. An illustrated article, describing the details of a petrol car and the working, and discussing many designs and types. 12000 w. Trans N E Coast Inst of Engrs & Shipbldrs—April, 1905. No. 69638 E.

The Métallurgique Petrol Cars. Illustrates and describes the interesting features of these cars. 1100 w. Auto Jour—May 13, 1905. No. 69814 A.

Pivot.

The 1905 Pivot Cars. Illustrated description of this French car. 600 w. Auto Jour—April 22, 1905. No. 69325 A.

Racer.

Mr. Lionel de Rothschild's Siddeley Racer. Illustrated detailed description of a fine example of automobile design and construction. The car is entered for the Gordon-Bennett race. 1800 w. Auto Jour—April 29, 1905. No. 69461 A.

Simms-Welbeck.

The Simms-Welbeck Cars. Drawings and description showing the general design of three types of automobiles constructed by this company. 1000 w. Autocar—May 13, 1905. No. 69699 A.

Touring Car.

Peerless 35-Horsepower Touring Car. Illustrated detailed description. 2800 w. Automobile—April 29, 1905. No. 69275.

Stevens-Duryea 20-Horse-power Touring Car. Illustrated description. 1000 w. Automobile—May 18, 1905. No. 69649.

Studebaker 20-Horsepower Touring Car. Illustrated detailed description of a car built in South Bend, Ind. 2200 w. Automobile—May 25, 1905. No. 69872.

The 20 H. P. Legros & Knowles Touring Car. Description and diagrams of an English made car. 900 w. Autocar—April 22, 1905. No. 69326 A.

COMBUSTION MOTORS.

Alcohol.

A Comparative Technical Study of Denaturized Alcohols (Etude Technique Comparative des Alcools Dénaturés). Lucien Périssé. A report of the tests upon the internal-combustion motors at the Vienna exhibitionn of 1904, using alcohol as fuel. Methods of denaturizing are given. 10000 w. Mem Soc Ing Civ de France—Feb., 1905. No. 69786 G.

Carburetters.

Carburetters. Abstract of a lecture by Mr. Mervyn O'Gorman before the Auto. & Cycle Engrs.' Inst. A study of the requirements, what has already been accomplished, and how to get the best results. 4000 w. Autocar—April 22, 1905. Serial. 1st part. No. 69462 A.

Diesel.

The Diesel Engine. W. H. Booth. Reports results of a test recently carried out on a Diesel engine of 150 b. h. p. 2800 w. Elec Mag—April 25, 1905. No. 69613 C.

Explosion Engines.

The Working of a Large Compound Explosive Engine on Petrol or Benzoline Spirit. E. Butler. A report of some experiments and tests made by the writer. 1000 w. Mech Engr—May 6, 1905. No. 69583 A.

Gas Engines.

Recent Gas and Oil Engine Developments. Thomas Holgate, in *Technics*. Reports the development as shown by engines exhibited at Earl's Court, giving illustrations. 3300 w. Sci Am Sup—May 13, 1905. No. 69491.

The Mechanical Efficiency of the Gas Engine. W. H. Booth. An explanation of the losses that occur and their cause, and a comparison with steam engine efficiency. 1500 w. Power—May, 1905. No. 69415 C.

Gasolene Engines.

Fuel Mixing Devices for Gasolene Engines. E. W. Roberts. Considers various types of carburetors, vaporizers, mixing valves, and generator valves, giving illustrations. 3800 w. Rudder—May, 1905. No. 69376 C.

Testing for Horse-Power and Fuel Consumption. A. E. Potter. Describes methods of testing gasolene engines. 3300 w. Rudder—May, 1905. No. 69374 C.

Gas-Producers.

Gas-Producer Power-Plants. Samuel S. Wyer. Gives facts relating to the design, operation and maintenance of gas-producer plants showing their advantages. 3300 w. Am Inst of Min Engrs—Feb., 1905. No. 69844.

Producer Gas Power. H. Williams. Discusses its application for factories, cold stores, &c., in place of steam power, pressure vs. suction gas plants, and comparative cost. 4000 w. Ice & Refrig—May, 1905. No. 69425 C.

The Riche Gas Producer. Dr. A. Gradenwitz. Illustrated description of two systems of gas-producing designed for burning waste wood, shavings and sawdust as well as anthracite coal or coke. 1200 w. Power—May, 1905. No. 69414 C.

The Testing of Gas Producers. Samuel S. Wyer. Description of methods for conducting tests. Also Bibliography of Gas Producers. 5000 w. Am Inst of Min Engrs—Feb., 1905. No. 69845 C.

Gas Turbine.

The Question of the Gas Turbine. Sidney A. Reeve. A review of the conclusions of Dr. Lucke, with especial reference to the mixed gas and steam turbine. 3500 w. Engineering Magazine—June, 1905. No. 69797 B.

Heat Engines.

The Junge Heat Engine System. H. Diederichs. Examines the charges at present laid against the gas engine, and the solutions Mr. Junge offers for overcoming the difficulties. 5700 w. Power—May, 1905. No. 69419 C.

Marine Engines.

Gas Producer and Gas Engine for Marine Use. George E. Walsh. Describes a modern marine producer gas plant, presenting some of its advantages. 1800 w. Marine Rev—May 11, 1905. No. 69531.

Marine Gas Engine. Illustrates and describes the construction proposed by Herr Capitaine, which has worked successfully in an experimental model. 1500 w. Engr, Lond—April 21, 1905. No. 69344 A.

The Gas Engine for Marine Motive Power. Alfred Gradenwitz. Describing successful installations of producers and engines on boats, showing the practical advantages. 3000 w. Engineering Magazine—June, 1905. No. 69793 B.

Petrol Engines.

A Large Petrol Engine. Illustrates a 100-H. P. petrol engine, giving a brief description. 500 w. Engr, Lond—May 12, 1905. No. 69837 A.

Power Gas.

Coal Gas and Its Rivals for Motive Power. Dugald Clerk. A lecture to the N. of Eng. Gas Mgrs.' Assn. Discusses fuel costs for power in England, and advocates a reduction in the price of gas for motive power. Urges the substitution of calorific power instead of illuminating power as the standard for gas manufacture. 5500 w. Jour Gas Lgt—May 2, 1905. No. 69499 A.

Gas as a Motive Power, and Its Relative Cost. W. H. Laurie. An illustrated article aiming to show that the gas engine with a suitable gas producer will generate power at less cost than any other source. 3500 w. Can Soc of Civ Engrs —March 23, 1905. No. 69646 C.

HEATING AND COOLING.

Indirect Heating.

Some Features of Indirect Heating. Konrad Meier. Explains the three systems of indirect heating, and the way of determining the best requirement or capacity of the apparatus. 5000 w. Eng Rec—May 27, 1905. No. 69913.

Refrigeration.

Refrigerating Plants on New United Fruit Company Steamers. Illustrates and describes the plants installed on these vessels fitted for carrying bananas. 2800 w. Marine Engng—May, 1905. No. 69299 C.

Standard Unit of Refrigeration. F. E. Matthews. An explanation of the proposition offered by the writer in which the nominal rating is based on the standard ton of 288,000 British thermal units per day, equivalent to the evaporation of 27 pounds of anhydrous ammonia per hour from the standard condition of 90 degrees liquid into 0 degrees saturated gas. 5700 w. Trans Am Soc of Mech Engrs, No. 067—June, 1905. No. 69554 C.

Shop Heating.

An Improvised Hot-Water Shop Heating System. Describes briefly an interesting adaptation of a waste steam boiler feed-water heating system to the heating of shops and offices, as outlined by A. A. Maver before the Canadian Ry. Club. 1500 w. Eng Rec—May 13, 1905. No. 69572.

Vacuum Steam Heating.

The Principles of Vacuum Steam Heating. George D. Hoffman. An explanation of how a heating plant may be run economically at less than atmospheric pressure. 2300 w. Dom Engng—May 6, 1905. No. 69398.

HYDRAULICS.

Electric Pumping.

Electrically Driven Pumping Machinery (Elektrisch Betriebene Wasserhaltung). H. Koch. Discussing the applications of electric motors to centrifugal and express reciprocating pumps, with especial reference to mining service. 5000 w. Elektrotech Zeitschr—May 4, 1905. No. 69772 B.

The Operation of Pumps by Electric Motors (Allgemeine Betrachtungen über die Pumpen mit Elektrischem Antrieb). H. Koch. Describing applications of electric motors to centrifugal pumps and to Riedler express pumps for mining service. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 15, 1905. No. 69755 D.

Hydro Electric.

See Electrical Engineering, Generating Stations.

Niagara.

Utilizing the Power of the Niagara Rapids. Alton D. Adams. A discussion of the various methods by which a large amount of power may be taken from the Niagara rapids below the Falls. 2500 w. Engineering Magazine—June, 1905. No. 69705 B.

Wheel-Pits and Tunnels for Niagara Power. Alton D. Adams. Illustrated description of pits on both the American and Canadian sides, with information of interest relating to them. 3500 w. Elec Rev, N Y—May 20, 1905. No. 69669.

Pumping.

Some Pumping Data. R. Gilman Brown. Gives figures collected from records kept at the Brunswick mine, Grass Valley, Cal., during the fall and winter of 1903-4. 1500 w. Eng & Min Jour—May 18, 1905. No. 69803.

The Harris System of Pumping with Compressed Air. Elmo G. Harris. Illustrated description of apparatus and principles governing its operation. 1800 w. Mines & Min—May, 1905. No. 69410 C.

Pumps.

A Compact Belt-Driven Pump. Illustrated description of a pump designed by H. F. Dunham for moderate capacities, which combines steam-economy with simplicity of structure and accessibility of parts. 1200 w. Eng News—May 4, 1905. No. 69372.

Some Types of Centrifugal Pumps. William O. Webber. Reviews briefly the development of centrifugal pumping, giving illustrations of types, and especially describing designs of the writer, and the development of the multiple-stage centrifugal pump. 3000 w. Trans Am Soc of Mech Engrs, No. 062—June, 1905. No. 69550 C.

Quebec.

Water-Powers of Quebec. J. C. Langelier. Information concerning some of the many great water-powers. Map. 1400 w. Can Engr—May, 1905. No. 69498.

Stream Flow.

See Civil Engineering, Waterways and Harbors.

Water-Hammer.

Water-Hammer in Pipes. J. Wright Clarke. Explains the meaning of the term and its cause, and the remedy. Ills. 2500 w. Plumb & Dec—May 1, 1905. Serial. 1st part. No. 69577 A.

Water Wheels.

The Buckets of Impulse Wheels (Ueber die Schaufelung des Löffelrades). Rudolf Escher. An examination of the theoretical form for buckets for water wheels of the Pelton impulse type. 2500 w. Schweiz Bauzeitung—April 20, 1905. No. 69732 B.

MACHINE WORKS AND FOUNDRIES.

Air Blast.

Air Blast for the Foundry Cupola. W. H. Carrier. Abstract of a paper read before the Buffalo Found. Assn. Discusses the merits of the fan and of the positive blowers, and their relative efficiency. 1700 w. Ir Age—May 11, 1905. No. 69457.

Casting.

The Relative Advantages of Casting from Above or Below (Guss von Oben—Guss von Unten). A. Messerschmitt. An examination of the influence of the method of pouring upon the strength and quality of the casting. 5000 w. Stahl u Eisen—April 15, 1905. No. 69737 D.

Castings.

The Causes and Remedies for Defects in Castings (Wie Entstehen in der Eisengiesserei Fehlgüsse und wie lassen sie sich Vermeiden). H. Fichtner. A discussion of the influence of methods of moulding, gating, venting, etc., upon the soundness of castings. 2000 w. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69704 D.

Chains.

Modern Methods of Manufacturing Welded Chain. Leslie B. Powell. Describes the old method of manufacture and the present method, illustrating the three important labor-saving machines used. 1700 w. Am Mach—Vol. 28, No. 19. No. 69501.

Clutch.

A New Form of Friction Clutch. Emile Guarini. Illustrated description of the Hele-Shaw clutch and some of its applications. 800 w. Sci Am Sup—May 20, 1905. No. 69626.

Dies.

Dies for Making and Driving Double-Pointed Tacks. S. A. Worcester. Illustrated description. 700 w. Am Mach—Vol. 28, No. 19. No. 69504.

Drill Grinder.

An Improved Grinding Machine for Twist Drills (Neue Schleifmaschine für Lochbohrer). Hermann Fischer. With numerous diagrams showing the manner in which the drill is held and presented to the emery wheel. 1000 w. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69710 D.

Electric Driving.

A Modern Electrically-Driven Manufacturing Plant. Illustrated description of the Ingersoll-Sergeant Drill Company's new works at Phillipsburg, N. J. 1400 w. Am Elect'n—May, 1905. No. 69357.

Electric Driving for Iron Works (Die Elektrische Kraftübertragung auf Hüttenwerken). F. Janssen. A discussion of the advantages of electric power for iron works, with plans for a complete power plant. Serial. Part I. 5000 w. Stahl u Eisen—May 1, 1905. No. 69738 D.

Electric Motor Application. Ernest G. Howard. Extracts from a paper read before the Connecticut Valley Metal Trades Assn. An account of the equipment for the shops of the Chapman Valve Mfg. Co. 2000 w. Ir Trd Rev—May 11, 1905. No. 69500.

Electric Power in Steel Works. Illustrates and describes a number of special applications of electric motors to steel works machinery. 1000 w. Engr, Lond—April 28, 1905. No. 69483 A.

Motor Drives in the Plant of the John Simmons Company. Illustrates and describes a number of interesting combinations in a New York shop. The aim was to make the machines capable of using high speed steel tools. 2000 w. Ir Age—May 25, 1905. No. 69855.

The Application of Electric Driving to Workshops (Antrieb durch Elektrische Motoren im Fabrikbetrieb). W. Zuppinger. Discussing especially the matter of belting from the electric motor to shafting for group driving, when large speed reductions are necessary. 3000 w. Schweiz Bauzeitung—April 15, 1905. No. 69731 B.

Foundry.

The Foundry of Scholten Bros. at Duisburg (Die Giesserei der Firma Gebr. Scholten in Duisburg). F. Wüst. Plans and description of a new foundry plant representing recent German practice. 3500 w. 1 plate. Stahl u Eisen—May 15, 1905. No. 69744 D.

The Sandycroft Foundry. Begins a detailed description, giving many illustrations. 2300 w. Engr, Lond—May 5, 1905. Serial. 1st part. No. 69597 A.

Interchangeable Parts.

Symbolling a Machine for Interchangeable Manufacture. F. W. McArdle. Describes a system with which the writer has had experience, which is particularly applicable to constructions that have many details. 2500 w. Amer Mach—Vol. 28, No. 19. No. 69505.

Keyway Cutting.

German Vertical Keyseating and Slotting Machine. Illustrated description of the machine and its operation. 800 w. Am Mach—Vol. 28, No. 21. No. 69860.

Lathes.

Electric Drive for Large Lathes. Oscar E. Perrigo. Illustrates and describes a method of applying the electric drive to existing lathes which has been found economical, convenient, and efficient. 700 w. Am Mach—Vol. 28, No. 18. No. 69380.

Feeds and Speeds for Lathe Work. T. A. Sperry. Gives results of observations at the works of the Cincinnati Milling Machine Company, showing the speeds and feeds at which iron and steel are being machined to-day. 1100 w. Am Mach—Vol. 28, No. 21. No. 69859.

Machine Tools.

Recent Machine Tools (Neuere Werkzeugmaschinen). Paul Möller. Illustrating some recent German designs for lathes and slotting machines. 2000 w. Zeitschr d Ver Deutscher Ing—April 22, 1905. No. 69706 D.

Molding.

Mounting a Shuttle-Box Pattern on a Molding Machine. John Weaver. Illustrates and describes a method of mounting patterns. 1600 w. Am Mach—Vol. 28, No. 21. No. 69858.

Molds.

New Method of Drying Large Molds. Henry Biegel. Illustrates and describes a method of drying with stoves. 700 w. Am Mach—Vol. 28, No. 19. No. 69503.

Pattern Making.

Developing the Pattern for a Copper Converter Hood Having a Round Top and an Irregular Base. John O. Wyler. Directions for this work, with diagrams. 2000 w. Boiler Maker—May, 1905. No. 69391.

Pattern Shops.

Pattern Shop System. Oscar E. Perrigo. An explanation of plans and systems of handling the work satisfactorily. 4200 w. Foundry—May, 1905. No. 69546.

Perforating.

Sheet-Metal Perforating. Edward F. Chandler. Illustrates and describes a complete punch and die equipment. 600 w. Am Mach—Vol. 28, No. 18. No. 69382.

Pipe Threads.

Gages for Briggs Standard Pipe Threads and for Standard Oil Well Casing. F. A. Stanley. An illustrated detailed description of the method followed in making a new set of Briggs reference gages. 3000 w. Am Mach—Vol. 28, No. 18. No. 69379.

Screws.

Note on Heads of Machine Screws. H. G. Reist. Remarks on the variation of size and shape and the inconvenience caused, giving formula and table showing the shapes and dimensions of size of screws ordinarily used. 450 w. Trans Am Soc of Mech Engrs, No. 064—June, 1905. No. 69551.

Stores.

The General Stores-Keeping Department of the Browning Engineering Co. Earl Harrison Browning. A fully illustrated article showing the stores keeping methods, forms and appliances of a modern machine works. 3500 w. Engineering Magazine—June, 1905. No. 69794 B.

Stoves.

Labor Saving in Stove Manufacture. John Magee. From a paper read before the Nat. Assn. of Stove Mfrs. Briefly considers the labor-saving machinery and tools used, and the labor-saving shop methods. 2000 w. Ir Trd Rev—May 18, 1905. No. 69648.

Tools.

A Chucking Machine Fixture. Charles R. Richardson. Illustrated description of a device found very useful. 1000 w. Am Mach—Vol. 28, No. 20. No. 69619.

Shop Tools and Devices. F. J. LeCard. Brief illustrated descriptions of devices for holding steady rest work on the live center, and other useful attachments. 1500 w. Am Mach—Vol. 28, No. 18. No. 69381.

Works.

The Works of the Birdsboro Steel Foundry and Machine Company. Illustrated description of the plant of what was formerly known as the Diamond Drill & Machine Co., which has greatly enlarged the scope of work and assumed the new name. 3500 w. Ir Age—May 11, 1905. No. 69456.

The Works of Messrs. Brown-Boveri & Co., of Baden, Switzerland. Emile Guarini. Illustrated detailed description of large electric construction works and their equipment. 1800 w. Am Mach—Vol. 28, No. 20. No. 69616.

MATERIALS OF CONSTRUCTION.

Alloys.

The Constitution of Iron-Carbon Alloys. E. Heyn. Translated from *Zeitsch. f. Elektro-Chemie.* The writer's views regarding the phenomena occurring on the quenching and on the solidification of iron-carbon alloys. 2000 w. Ills. Ir & Steel Mag—May, 1904. Serial. 1st part. No. 69686 D.

Vanadium and Titanium. Hans Goldschmidt. The first part of an article on the effect of vanadium and titanium on steel. The present number deals with vanadium. 2000 w. Elec-Chem and Met Ind—May, 1905. Serial. 1st part. No. 69446 C.

Bearing Metals.

The Microstructure and Frictional Characteristics in Bearing Metals. Melvin Price. A record of investigations carried out in the laboratories of Columbia University. Considers the law of variation of the amount of friction with the velocity of sliding, and the theories of Charpy and Prof. Goodman. Ills. 10000 w. Trans Am Soc of Mech Engrs, No. 072—June, 1905. No. 69559 D.

Bronze.

Manganese Bronze. Percy Longmuir. An examination of some of the properties of this alloy. 1600 w. Foundry—May, 1905. No. 69545.

The Monumental Treatment of Bronze. J. Starkie Gardner. A review of the history of bronze as applied to monumental statuary and architectural decoration. Discussion. Ills. 10800 w. Jour Soc of Arts—May 12, 1905. No. 69698 A.

Cast-Iron.

Cast-Iron: Crushing Loads and Microstructure. W. J. Keep. A report of tests given with the object of making more complete the society's records of tests on cast iron. Ills. 2000 w. Trans Am Soc of Mech Engrs, No. 065—June, 1905. No. 69552 C.

Metallography Applied to Foundry Work. Albert Sauveur. The first of a series of articles considering metallography in its application to the testing of castings. 2000 w. Foundry—May, 1905. Serial. 1st part. No. 69543.

Corrosion.

The Protection of Copper and its Alloys against Corrosion from Sea Water (Schutz des Kupfers und seiner Legierungen gegen die Zerstörung durch Seewasser). F. Uthemann. Data and results of experiments upon a number of alloys suitable for marine condenser tubes. 2000 w. Zeitschr d Ver Deutscher Ing—May 6, 1905. No. 69712 D.

The Corrosion of Copper in Sea Water. Translation of an article by Herr Uthemann, on a number of interesting experiments carried out with a view to discovering an effective means of protecting copper and its alloys against corrosion through the action of sea water. 2800 w. Engr, Lond—May 5, 1905. No. 69598 A.

"Fatigue."

Note on the Failure of an Iron Plate through "Fatigue." Sidney A. Houghton. Read before the Iron & Steel Inst. Describes a case and investigates the causes. 1700 w. Ir & Coal Trds Rev—May 12, 1905. No. 69890 A.

Hardening.

A Salt-Bath Furnace for Steel Hardening. Illustrates and describes an apparatus in which a fusible salt liquid is utilized for heating purposes; known as the Brayshaw furnace. 1300 w. Sci Am Sup—May 20, 1905. No. 69627.

Low Temperatures.

Experiments Relating to the Effect on Mechanical and Other Properties of Iron and Its Alloys Produced by Liquid Air Temperatures. R. A. Hadfield. Read before the Iron & Steel Inst. An account of early and recent research work in this field. 11000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69884 A.

Steel.

Steel: Its Manufacture and Classification, with Special Reference to Hardening and Tempering. R. B. Hodgson. The present article considers briefly the methods of manufacture, comparison, between Siemens and Bessemer steels, and crucible cast steel. 2300 w. Prac Engr—May 5, 1905. Serial. 1st part. No. 69580 A.

Tool Steel.

The Development and Use of High-Speed Tool Steel. A discussion of J. M. Gledhill's paper. 5500 w. Am Inst of Min Engrs—May, 1905. No. 69854.

The Steel Hardening Metals. Joseph Hyde Pratt. From a paper on "Mineral Resources of the United States," issued by the U. S. Geol. Survey. Gives a list of the metals included under this head, discussing the properties resulting from their additions. 3500 w. Mach, N Y—May, 1905. No. 69304 C.

MEASUREMENT.

Ductility.

A Study of the Limit of Ductility (Zur Kenntnis der Streckgrenze). C. Bach. Experiments to determine the relation of the flow of metals under stress to the ultimate breaking strength. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69702 D.

Fragility.

Test for Fragility. Thorsten Y. Olsen. Abstract of a paper read before the Phila. Found. Assn. An illustrated article explaining the Fremont method of determining the fragility of iron and steel. Also discussed. 4500 w. Foundry—May, 1905. No. 69547.

Instruments.

Small Instruments of Measurement. Joseph Horner. Illustrates and describes various small instruments of precision, giving some account of the care needed in their manufacture and their uses. 3500 w. Cassier's Mag—May, 1905. No. 69285 B.

Laboratory.

The Material Testing Laboratory of the Pless Mines at Waldenburg in Silesia (Die Untersuchung von Verbrauchsmaterialien im Laboratorium der Fürstlich Plesschen Bergwerke zu Waldenburg in Schlesien). Fr. Schreiber. With results of tests of lubricants, belting, packing, and general supplies. Two articles. 7000 w. Glückauf—April 29, May 6, 1905. No. 69749 each D.

Measuring Machines.

Continuous Measuring and Mixing of Crushed or Powdered Materials in Accurate Proportions. E. N. Trump. Briefly outlines various methods in use, and gives an illustrated description of a measuring table, and explains how a combination will regulate the proportioning and mixing. 3500 w. Trans Am Soc of Mech Engrs, No. 071—June, 1905. No. 69558 C.

Oil Tester.

The Lahmeyer Oil Tester. H. E. Hodgson. Illustrated detailed description of an apparatus designed to be driven by an electric motor, by mechanical means, or by hand, explaining its operation. 3300 w. Elec Engr, Lond—April 28, 1905. No. 69468 A.

Pyrometry.

Modern Thermometric Apparatus for High Temperatures. L. Ramakers. An illustrated account of a type of apparatus recently introduced by the Siemens & Halske Company, of Berlin. 1100 w. Sci Am—May 27, 1905. No. 69869.

Test Bars.

Test Bars. B. J. Dunning. Gives the writer's experience in trying to determine what the test bar tells. 1400 w. Foundry —May, 1905. No. 69544.

Units.

Making the Best of Present Units. Sanford A. Moss. Suggestions for a system of measurements that will give the calculations in decimals. Also editorial. 1800 w. Am Mach—Vol. 28, No. 20. No. 69620.

POWER AND TRANSMISSION.

Belts.

Belt Creep. William W. Bird. Gives a report of investigations of the minimum amount of slip of a belt in transmitting power, concluding that for the common leather belt running under ordinary conditions the creep should not exceed one per cent. 1000 w. Ills. Trans Am Soc of Mech Engrs, No. 073—June, 1905. No. 69560.

Greater Power for Belt-Driven Plants. Frank Jordan. Claims that "the slacker the belt, the greater the power transmittable." 1800 w. Prac Engr—May 5, 1905. No. 69581 A.

Coal Handling.

The Shadyside Coal Storage Plant of the New York Edison Co. Illustrated description of the plant and its handling apparatus. It provides for 100,000 tons of anthracite and 50,000 tons of bituminous coal. 1500 w. Eng Rec—May 13, 1905. No. 69569.

Clutch.

An Improved Clutch (Sur un Nouvel Embrayage). MM. de Guiche and Gillardoni. Describing a clutch consisting of a friction shoe acting upon the interior of a drum by means of a toggle link. 1000 w. Comptes Rendus—April 25, 1905. No. 69724 D.

Compressed Air.

Air Compression at Altitude. Frederick M. Hitchcock. Showing the increase of power required at altitude to compress a volume of air equivalent in effect to a given volume at sea level. 1200 w. Mines & Min—May, 1905. No. 69409 C.

Classification of Air Compressors. Robert Peele. Gives classification by characteristics purely as engines, by mode of dealing with heat produced, by types of valves and valve motions. 2500 w. Mines & Min—May, 1905. No. 69403 C.

Compound Air Compression. Frederick M. Hitchcock. Considers the temperatures attained, effects of cooling, power consumed, and saving by compound compared with simple compression. 2500 w. Mines & Min—May, 1905. No. 69411 C.

Compressed Air Grain Shoveling. J. G. Westbrook. Illustrates and describes the equipment tor a large grain-house. 800 w. Compressed Air—May, 1905. No. 69632.

Compressed Air on the Pacific Coast. Edward A. Rix. Illustrates and describes compressors driven by direct-connected water-wheels, and the various methods of using and reheating air. 4000 w. Mines & Min—May, 1905. No. 69399 C.

Compression of Air and Volumetric Efficiency. E. A. Rix. Gives theoretical data and their application to practical problems of compressed air machinery. 4800 w. Mines & Min—May, 1905. No. 69405 C.

Efficiency Test of a Nordberg Air Compressor at the Burra Burra Mine of the Tennessee Copper Company. J. Parker Channing. Describes the conditions and the methods of testing, reporting results. 1500 w. Mines & Min—May, 1905. No. 69401 C.

Electrical Compression of Air for Mining Purposes. Lucius I. Wightman. An illustrated article describing the electrical air compressor, and considering driving by belts, ropes, gears, silent chains, and direct connections, sizes of units, &c. 7400 w. Mines & Min—May, 1905. No. 69413 C.

Long Stroke Pump Valves (Vollhubige Pumpenventile). F. Strnad. Illustrating improved forms of balanced, cushioned ring-valves, especially adapted for gas and vacuum pumps and for air compressors. 5000 w. Glückauf—April 22, 1905. No. 69746 D.

Long-Stroke Valves for Compressors (Vollhubventile für Kompressoren). Ferd. Strnad. Describing an improved form of cushioned valve for high speed air compressors. 2500 w. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69708 D.

Reheaters and Reheating. States the advantages gained by reheating, giving illustrated descriptions of different types of reheaters. 1800 w. Mines & Min—May, 1905. No. 69408 C.

The High-Speed Compressor. Joseph D. Cone. Explains its advantages for certain work, giving examples of compressors direct driven by electric motors, gas engines, and steam. Ills. 2400 w. Mines & Min—May, 1905. No. 69406 C.

The Taylor Hydraulic Air Compressor. William O. Webber. On the advantages of the system and its high efficiency, discussing some distinct features and peculiarities. 1300 w. Mines & Min—May, 1905. No. 69412 C.

Vertical Air Compressors. Brief illustrated descriptions of enclosed and open two-stage compound compressors as examples of recent English practice, giving a test record. 800 w. Mines & Min—May, 1905. No. 69402 C.

Cranes.

Electric Locomotive Cranes. Illustrates four different types of electrically worked locomotive cranes, giving brief descriptions. 600 w. Engr, Lond—April 21, 1905. No. 69343 A.

Fundamental Principles of Electric Crane Design (Grundbedingungen für den Bau von Elektrisch Betriebenen Laufkranen). S. Herzog. A very complete discussion of the detailed design of the modern three-motor electric traveling crane. 3500 w. Zeitschr f Elektrotechnik —May 14, 1905. No. 69781 D.

Gears.

A General Theory of Spur Gearing. Robert A. Bruce. Gives a general method for determining the correct forms for the profiles of wheel teeth which does not demand a knowledge of mathematics. 1600 w. Prac Engr—May 12, 1905. Serial. 1st part. No. 69816 A.

An Interesting Pair of Spiral Intermittent Gears. Illustrates and describes the operation of a pair of intermittent gears having peculiar characteristics. 700 w. Am Mach—Vol. 28, No. 21. No. 69857.

Some Points About Tumbler Gears. A. L. de Leeuw. Discusses the line of action, and the calculating the strain on the different parts. Diagrams. 2300 w. Am Mach—Vol. 28, No. 19. No. 69502.

Handling Grain.

Grain Storage and Manipulation at the Quayside. Brysson Cunningham. Illustrates and describes modern methods, with special reference to the practice at British ports. 3000 w. Cassier's Mag—May, 1905. No. 69286 B.

Hoisting.

Modern Steam Hoisting Machinery. A. M. Levin. Illustrates and describes some features in the design of hoisting engines and auxiliaries. 3800 w. Mach, N Y—May, 1905. No. 69302 C.

Pneumatic Tubes.

The Pneumatic Tube System of St. Louis. Edward D. Sabine. A description of the system of the Post Office Department and its successful working. 2500 w. Compressed Air—May, 1905. No. 69631.

Shafting.

Precise Lining of Large Shafting. W. I. Fleck. Describes a particular setting which illustrates the more important features of the method, giving a drawing of the relative position of the horizontal and vertical boxing, shafting, gearing, &c., necessary for the transmission of 1,600 H. P. from four water wheels. 700 w. Min & Sci Pr—May 20, 1905. No. 69915.

Variable Speeds.

Variable Speed Mechanisms. The present article considers their development and general principles. Ills. 2200 w. Mach, N Y—May, 1905. Serial. 1st part. No. 69303 C.

STEAM ENGINEERING.

Binary Vapor.

Waste Heat Engines (Abwärmekraftmaschine). H. Schröter. Data and results of tests upon two binary-vapor engines of the Josse sulphurous acid type, showing the gain by utilizing the heat in the exhaust steam. 1800 w. Zeitschr d Ver Deutscher Ing—May 6, 1905. No. 69713 D.

Boilers.

Boiler Room Economics. F. A. Lankashier. Abstract of a paper presented before the Iowa Elec. Assn. Especially considers boilers and grates, discussing types. 2500 w. Engr, U S A—May 1, 1905. No. 69362 C.

Cleaning Boilers. James T. Fennell. Gives suggestions for properly blowing off a boiler, and how to get a boiler ready for cleaning out. 1800 w. Power—May, 1905. No. 69416 C.

Marine Type Water Tube Boilers. C. C. Thomas. A review of the investigations and report of the Boiler Committee appointed by the British Admiralty to examine the water-tube boiler question in all its details and make recommendations regarding the boilers to be used on British ships of war. Ills. 2500 w. Sib Jour of Engng—May, 1908. No. 69660 C.

The Renard Boiler (La Chaudière du Colonel Renard). Describing a light weight flash steam boiler designed by the late Col. Renard. 800 w. Génie Civil—April 22, 1905. No. 69718 D.

Boiler Explosion.

The St. Lazare Boiler Explosion. An illustrated article reviewing the report of M. Charles Frémont in regard to the cause of the explosion of this locomotive boiler, on July 4, 1904. Also comments on the earlier report of M. Sylvain Périssé. 3000 w. Engr, Lond—April 21, 1905. Serial. 1st part. No. 69341 A.

Boiler Furnaces.

Repairing Partly Collapsed Cylindrical Furnaces. John P. Cosgro. Describes method of remedying an injury which may occur from overloading the boilers. Ills. 2000 w. Am Inst of Min Engrs—May, 1905. No. 69850.

The Effect of Oil on Boiler Furnaces. D. B. Morison. Read before the N. E. Coast Inst. of Engrs. & Shipbuilding. Discusses means of determining the ultimate strength of a boiler furnace and the effect of oil upon it, giving a report of investigations. Ills. 3700 w. Engng—May 5, 1905. Serial. 1st part. No. 69595 A.

Chemistry.

Engine Room Chemistry.—Introductory. Augustus H. Gill. The first of a series of articles aiming to make engineers somewhat familiar with the substances with which they deal, as fuel, water and oil, and some points in connection with their use. 3000 w. Power—May, 1905. Serial. 1st part. No. 69417 C.

Condensing.

Cooling Water for Condensers. Ernest R. Briggs. Discusses methods in use and explains a method for finding correctly the quantity of water required for condensing purposes. Ills. 1600 w. Am Mach—Vol. 28, No. 20. No. 69618.

Diagrams.

The Theory of Steam Engine Diagrams (Beitrag zur Theorie der Dampfmaschinendiagramme). Viktor Blaess. A discussion of the influence of the dimensions of steam passages upon indicator diagrams, based upon the experiments of Gutermuth upon the flow of steam. 2000 w. Zeitschr d Ver Deutscher Ing—April 29, 1905. No. 69709 D.

Efficiency.

Notes on Efficiency of Steam Generating Apparatus. A. Bement. A paper suggested by the discussion of a previous paper on "More Exact Methods for Determining the Efficiency of Steam Generating Apparatus." Considers the efficiency of the boiler and of the furnace, and gives experimental results. Ills. 4000 w. Trans Am Soc of Mech Engrs, No. 074—June, 1905. No. 69561 C.

Some Notes on the Efficiency of Steam Plant. Walter A. Vignoles. Discusses points in connection with the running of central stations, based on tests made, and giving conclusions. 4000 w. Elect'n, Lond—April 28, 1905. No. 69472 A.

Engines.

6,000-I.H.-P. Engines for the Manchester Corporation. Illustrated description of a pair of vertical slow-speed engines, which are believed to be the largest at present existing in Europe. 800 w. Engng—April 28, 1905. No. 69478 A.

The Lentz Engine. Illustrated description of a large compound engine for coupling direct to a dynamo, working with superheated steam of high temperature. 800 w. Engr, Lond—April 21, 1905. No. 69347 A.

Fuel Economy.

The Province of the Fuel Expert. G. A. Hutchinson. Considers some of the problems likely to present themselves in connection with a steam plant. 3800 w. Eng & Min Jour—May 25, 1905. No. 69903.

Fuels.

Molasses as Fuel. R. Terry, S. Arnold, and H. Fisher. Gives report of investigation carried out in the Mechanical Engineering Laboratories of Columbia University to determine its efficiency when atomized in conjunction with fuel oil. Ills. 3500 w. Sch of Mines Qr—April, 1905. No. 69635 D.

Governors.

Steam Engine Governors. Considers points in connection with their design. 2700 w. Mech Engr—April 22, 1905. Serial. 1st part. No. 69327 A.

Heating Surface.

The Value of Heating Surface for Steaming and Superheating in Locomotive Boilers (Der Wert der Heizfläche für die Verdampfung und Ueberhitzung im Lokomotivkessel). H. Strahl. A discussion of experiments upon the transmission of heat in various parts of a locomotive boiler. 4000 w. Zeitschr d Ver Deutscher Ing—May 6, 1905. No. 69711 D.

Indicators.

Indicator Inertia. Deductions from engine trials made by G. S. Rose and G. Savory at Sibley College, U. S. A. 1200 w. Engng—May 12, 1905. No. 69828 A.

Paper Mills.

Steam Engineering in Paper Mills. E. S. Farwell. Considers the special problems of paper mills which are not common to all steam plants, showing where attention is needed. 2500 w. Cassier's Mag—May, 1905. No. 69284 B.

Piping.

The Steam Piping of a Small Lighting Station. R. T. Strohm. Describes the two systems in general use, explaining the advantages of each. 1600 w. Am Elect'n—May, 1905. No. 69358.

Power Plants.

See Electrical Engineering, Generating Stations.

Smoke.

Smoke and Its Abatement. Charles H. Benjamin. A discussion of the problem of abating the smoke from bituminous coal. 6500 w. Trans Am Soc of Mech Engrs, No. 060—June, 1905. No. 69548 C.

Steam Turbines.

Can a Steam Turbine be Started in an Emergency Quicker Than a Reciprocating Engine of the Same Power? A. S. Mann. Showing that the turbine can be brought up to speed much quicker than the engine. 1400 w. Trans Am Soc of Mech Engrs, No. 068—June, 1905. No. 69555.

Flow of Steam Through Turbine Nozzles. Newton Wright. Gives formulas for calculating the energy of 1 lb. of steam. 3000 w. Prac Engr—May 12, 1905. No. 69818 A.

Steam Turbines. A discussion, opened by Prof. H. W. Spangler. Ills. 10500 w. Jour Fr Inst—May, 1905. No. 69637 D.

The De Laval Turbine. W. S. Ford. A discussion of this steam turbine, its operation, efficiency, &c. Ills. 2000 w. Sib Jour of Engng—May, 1905. No. 69661 C.

See also Marine and Naval Engineering.

Superheaters.

Performance of a Superheater. A. Bement. Gives diagrams plotted from a large number of experiments, discussing the results shown. 700 w. Trans Am Soc of Mech Engrs, No. 076—June, 1905. No. 69563.

Specific Heat of Superheated Steam. R. C. H. Heck. Describes the first method used for the determination by measurement of total heat, and experimental work in this field. 2000 w. Power—May, 1905. No. 69418 C.

Superheated Steam. J. L. Moore. Explains the aim in the use of superheated steam, gives results of tests, and conclusions. General discussion. 3500 w. Pro Engrs' Soc of W Penn—May, 1905. No. 69641 D.

Vacuum.

The Effects of Vacuum on Steam-Engine Economy. R. M. Neilson. Mr. Neilson's second paper describes the leading types of condensing apparatus, and their operation. 3000 w. Engineering Magazine—June, 1905. No. 69796 B.

The Measurement of Vacuum. C. Turnbull. Read before the Newcastle Loc. Sec. of the Inst. of Elec. Engrs. Remarks on the methods and the importance of vacuum measurements. 700 w. Engr, Lond—April 21, 1905. No. 69349 A.

Valve Gear.

Steam Actuated Valve Gear. W. H. Collier. Illustrated description of a 14 x 30 engine running 100 revolutions per minute, developing from 80 to 120 h.-p., with a statement of the advantages claimed. 1800 w. Trans Am Soc of Mech Engrs, No. 061—June, 1905. No. 69549.

Vibration.

Counterweights for Large Engines. D. S. Jacobus. Discusses the effects from the application of counterweights to an exceptionally large engine to lessen the vibration, with satisfactory results. An investigation of the action of the counterweights, and their effect on other electrical problems. Ills. 4500 w. Trans Am Soc of Mech Engrs, No. 069—June, 1905. No. 69556 C.

Water Purification.

The Development of Water Purification in the United States. C. Herschel Koyl. A review of the subject, especially the work of the Ry. Mas. Mechs.' Assn. commencing in 1870, and a description of water-softening machines. 3500 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69513.

MISCELLANY.

Aeronautics.

The Longitudinal Stability of Dirigible Balloons (Sur la Stabilité Longitudinale des Ballons Dirigeables). L. Torres. A review of the method suggested by Col. Renard, showing the disturbing effect of weight at the rear of the balloon. 1200 w. Comptes Rendus—April 10, 1905. No. 69722 D.

The Montgomery Aeroplane. Illustrated description, with an account of the successful trial on April 29th. 1600 w. Sci Am—May 20, 1905. No. 69622.

Carpet Cleaning.

Automobile Compressed Air Plant for Carpet Cleaning. Illustrated description of a novel form of motor vehicle recently built for service in South Wales. 500 w. Engr, Lond—April 21, 1905. No. 69346.

Force.

The Notion of Force (Der Kraftbegriff). H. Wehage. An examination of the correct definition and conception of the mechanical term force. 1800 w. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69703 D.

Gas Bottles.

Bottles for Compressed Air and Liquified Gases (Flaschen zur Aufnahme Verflussigter und Verdichteter Gase). A. Martens. Data and results of tests of containers for gases under pressures up to 400 atmospheres, with comments on various materials for this service. 4000 w. Zeitschr d Ver Deutscher Ing—April 15, 1905. No. 69701 D.

MINING AND METALLURGY

COAL AND COKE.

Borneo.

Coal Mining in Borneo. Extracts from a paper by James Roden, read before the Min. Inst. of Scotland. Gives details of some of the mines and their methods of working. 1500 w. Col Guard—May 5, 1905. No. 69592 A.

The Government Mines, Sadong-Sarawak, Borneo. Extracts from a paper by B. Hart Huxham, read before the S.-Wales Inst. of Engrs. Information in regard to this coalfield and its development. 2000 w. Col Guard—April 28, 1905. Serial. 1st part. No. 69474 A.

Coal Cutters.

Compressed Air Coal Cutters. L. T. Wightman. An illustrated description of the new Ingersoll type of puncher, also of the new "Radial" coal cutter. 3000 w. Mines & Min—May, 1905. No. 69407 C.

Coal Dust.

Separation of Dust from Coal. Explanatory drawings of two systems of recovering the very fine dust in a condition fit for firing, or briquette making. 1000 w. Ir & Coal Trds Rev—May 5, 1905. No. 69603 A.

Coal Fields.

The Known Coal Fields of the United States. E. W. Parker. Interesting information concerning the coal deposits, with map showing areas of coal bearing formations. 3000 w. Min Wld—May 6, 1905. No. 69422.

Coal Lands.

Recent Practice in Examination of Coal Lands. George H. Ashley. States the main things to be determined, and outlines the methods now used. 1700 w. Min Wld—May 6, 1905. No. 69424.

Colorado.

The Occidental and Other Coal Mines of Huerfano County, Colorado. Arthur Lakes. An illustrated description of the geology and development of the region. 1800 w. Mines & Min—May, 1905. No. 69400 C.

The South Park Coal Field. A. Lakes. Description of this region, giving illustration showing coal line. 700 w. Min Rept —April 27. 1905. No. 69291.

Mexico.

Mexican Coal Deposits. Kirby Thomas. Information concerning the deposits, their value, and degree of development. 1800 w. Min Wld—May 6, 1905. No. 69423.

Sampling.

Commercial Value of Coal Mine Sampling. Marius R. Campbell. Recommends certain rules for mine sampling, based on experience in receiving coal for the government coal-testing plant at St. Louis. 1600 w. Min Wld—May 20, 1905. No. 69692.

Stope Fillings.

The Compression of Stope Fillings. Bergassessor Jacob Oberhausen, in *Glückauf*. Gives data as to the compressibility of the filling derived from experiments made at shaft No. 2 of the Kaiser mine in the Ruhr coal district. 1200 w. Sch of Mines Qr—April, 1905. No. 69633 D.

COPPER.

Anaconda.

The Metallurgy of Copper at Anaconda, Montana. A. P. Mallon. Outlines the rather complicated treatment of the ore, tracing its changes from the concentrator to the shipping from the refinery. 1500 w. Min & Sci Pr—May 20, 1905. No. 69914.

Arizona.

Geology of the Cochise Mining District, Arizona. Robert P. Franke. Illustrated description of this copper district and its ores. 700 w. Min Rept—May 18, 1905. No. 69696.

Ore Deposit.

Notes on a Low Grade Copper Ore Deposit in the Himalayas. F. J. Stephens. Read before the Inst. of Min. & Met. Gives a description of the general geology of the region, and of the ore deposit. 2500 w. Min Jour—May 20, 1905. No. 69923 A.

Ores.

Platinum and Palladium in Certain Copper Ores. Thomas T. Read. Deals with the presence of platinum in the rich copper sulphide ore of the Rambler mine, in Wyoming. 2500 w. Eng & Min Jour —May 25, 1905. No. 69902.

Slag-Treatment.

Improved Method of Slag-Treatment at Argo. Harold V. Pearce. Describes the improved copper smelting practice at this plant in Colorado. Ills. 2800 w.

Am Inst of Min Engrs—May, 1905. No. 69849.

GOLD AND SILVER.

Amalgamation.

Effect of Salt and Bluestone on Mercury in Pan Amalgamation. A. E. Drucker. Explains the reactions which show the need of bluestone and salt in the treatment of silver ores when silver sulphide is present. 1000 w. Min & Sci Pr—May 20, 1905. No. 69916.

Assaying.

Correcting an Error in the Fire Assay. Charles Finley Easton. Discusses the unavoidable errors in fire assay, and describes an improvement which is based on the recovery of losses of gold by cupellation, giving results of some experiments. 2800 w. Min Rept—May 18, 1905. No. 69695.

Bornite Ores.

Bornite Ores of British Columbia and the Yukon Territory. William M. Brewer. Read before the Can. Min. Inst. Gives the history of the discovery of this ore, and a study of the geology and mineralogy of the deposits. 3300 w. Can Min Rev—April, 1905. No. 69289 B.

Cobalt-Silver.

On the Discoveries of Cobalt Silver Ores in Ontario. A brief account of the discovery, describing the deposits, and giving information of the present operating properties. Ills. 1500 w. Can Min Rev—April, 1905. No. 69287 B.

Cripple Creek.

The Cripple Creek District. John Wellington Finch. Discusses present conditions, reviewing the past year, the discoveries and development, and the general adoption of the leasing system. 4500 w. Min Mag—May, 1905. No. 69536 C.

Dredges.

A Large Gold Dredger. Illustrated description of the construction and operation of a modern dredger said to be the largest placer mining dredger in the world. Also reviews the early history of dredging in California. 3800 w. Min & Sci Pr—May 6, 1905. No. 69526.

Egypt.

An Egyptian Gold Mine. H. R. Sleeman. Read before the Inst. of Min. & Met. Describes the property known as the "Haimur," situated in the Nubian Desert, which shows unusual characteristics, also the ancient methods of mining and treating the ore. 4000 w. Min Jour—May 20, 1905. No. 69924 A.

Gold.

Gold and Its Associations. George P. Merrill. Gives a list of the associations shown in a collection at the National Museum. 2000 w. Eng & Min Jour—May 25, 1905. No. 69905.

India.

Notes on the New Dharwar Gold Field of India. R. O. Ahlers. A description of this recently opened field. 4500 w. Inst. of Min & Met—April 13, 1905. No. 69329 D.

Mexico.

La Mina Santa Francisca, Mexico. Edward H. Cook. An illustrated description of this silver mine, with a review of its history. 2000 w. Min Mag—May, 1905. No. 69537 C.

The Hostotipaquillo District, Jalisco. William N. Cummings. Map and description of this silver-gold district in Mexico. 2000 w. Eng & Min Jour—May 18, 1905. No. 69801.

The Moctezuma District, Mexico. M. Clere. An illustrated brief account of the mining conditions in the northern part of this district. Copper, silver and gold, with other ores are mined. 2500 w. Eng & Min Jour—May 25, 1905. No. 69907.

Milling.

Milling Gold Ores. Algernon Del Mar. A warning in regard to mill construction and fast crushing, unless the gold can be saved as fast as the ore is crushed. 900 w. Min & Sci Pr—May 13, 1905. No. 69674.

Milling Practice at the Camp Bird. Stephen L. Goodale. Describes the method of treating gold ores at this Colorado mine. Ills. 1300 w. Eng & Min Jour—May 4, 1904. No. 69388.

Mill Practice on the Rand. G. A. Denny. Illustrated description of a representative ore reduction and slimes treatment plant. 1200 w. Min Mag—May, 1905. No. 69534 C.

New Zealand.

The Hauraki Goldfields. Percy Morgan. Letter to the editor, discussing a recent article by Waldemar Lindgren on this subject. 2300 w. Eng & Min Jour—May 4, 1905. No. 69390.

Placer Mining.

Placer Mining in Antiognia, Colombia. F. F. Sharpless. Description of this field, with remarks on the work that has been done, the difficulties, &c. 2500 w. Eng & Min Jour—May 25, 1905. No. 69906.

Precipitation.

Precipitation of Gold and Silver from Cyanide Solutions. W. J. Sharwood. Considers the recovery of precipitation of gold and silver from their cyanide solutions. 800 w. Min & Sci Pr—April 29, 1905. Serial. 1st part. No. 69376.

Quebec.

The Bed-Rock of the Gilbert River Gold Fields, Quebec. John A. Dresser. Describes the character of the rock, discussing the conclusions indicated. 1000 w. Can Min Rev—April, 1905. No. 69288 B.

Queensland.

Charters Towers District, Queensland, Australia. C. M. Naylor. Gives the history of this field, the methods of work, metallurgical treatment of the ore, and the present condition of the industry. 2500 w. Min & Sci Pr—April 29, 1905. No. 69395.

Refining.

Note on the Refining of Base Bullion. Walford Dowling. Describes a method employed by the writer for the refining of very base bullion. General discussion. 2200 w. Jour Chem, Met, & Min Soc of S Africa—March, 1905. No. 69815 E.

Reprecipitation.

Reprecipitation of Gold from Cyanide Solutions and Absorption of Gold by a Wooden Leaching Vat. A. N. Mackay. Read before the Inst. of Min. & Met. Describes two cases of reprecipitation, and the case of absorption. 900 w. Min Jour—May 20, 1905. No. 69922 A.

Smelting.

Customs Smelting in Australia. Explains the circumstances that prevent the business from becoming profitable. 1600 w. Eng & Min Jour—May 11, 1905. No. 69507.

Stamp Stems.

Retapering the Broken Ends of Stamp Stems. Paul J. Johnson. Sketch and explanation which will enable one to retaper the stems on the floor of the mill. 500 w. Min Rept—May 25, 1905. No. 69921.

Tube Mills.

First Results of Tube Mill Practice at the Treasury Gold Mine. H. Leupold. Gives the results of the first two runs. 1600 w. Jour S African Assn of Engrs—March, 1905. No. 69873 F.

Tube Milling of Gold Ores. George P. Scholl. An illustrated article giving a general idea of the construction of tube mills and their operation, and data regarding installations. 4000 w. Min Mag—May, 1905. No. 69535 C.

IRON AND STEEL.

Asphyxiation.

Accidents Due to the Asphyxiation of Blast Furnace Workmen. B. H. Thwaite. Read before the Iron & Steel Inst. A discussion of the dangers, giving suggestions with a view to securing comparative immunity from fatalities. 2800 w. Ir & Coal Trds Rev—May 12, 1905. No. 69891 A.

Bertrand Thiel.

Recent Developments of the Bertrand-Thiel Process in the Manufacture of Steel. John H. Darby. Read before the Iron & Steel Inst. A résumé of recent developments. Ills. 1800 w. Ir & Coal Trds Rev—May 12, 1905. No. 69886 A.

Blast Furnaces.

An Improvement in Cooling Jackets for Blast Furnaces. David Baker. Describes a jacket, designed by the writer, where the water collecting trough is outside of the furnace. Ills. 1400 w. Ir & Steel Mag—May, 1905. No. 69679 D.

Stock-Distribution and Its Relation to the Life of a Blast-Furnace Lining. Discussion of Mr. Baker's paper. 2700 w. Am Inst of Min Engrs—May, 1905. No. 69853.

Sulphur in Coke and Its Behavior in the Blast Furnace. Prof. F. Wuest, and P. Wolff. A report of investigations and conclusions. 8300 w. Ir & Coal Trds Rev—May 12, 1905. No. 69892 A.

The Blast-Furnace Gas-Power Plant at the Ilseder Iron and Steel Works. G. Hooghwinkel. Illustrates and describes the equipment and working of the plant. 1200 w. Elec Engr, Lond—May 12, 1905. No. 69823 A.

The Cleaning of Blast-Furnace Gas. Axel Sahlin. Read before the Iron & Steel Inst. Considers the process of cleaning as regards the degree of purity reached, and the cost of reaching it. 4000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69888 A.

The Preheating Zone of the Blast Furnace (Die Vorwärmzone des Hochofens). Fr. Schraml. Discussing methods of utilizing the heat of the waste gases for warming the charge before it is delivered into the shaft of the furnace. 3000 w. Stahl u Eisen—May 15, 1905. No. 69742 D.

Blowing Engines.

Gas Blowing Engines. Tom Westgarth. Abstract of a paper before the West of Scotland Iron and Steel Inst. Gives illustrations of various types, with brief descriptions, and information in regard to the running and the care and cost. 2000 w. Engr, Lond—May 5, 1905. No. 69602 A.

Concentration.

The Concentration of Iron Ores (Ueber Anreicherung von Eisenerzen). Dr. A. Weiskopf. An examination of the various magnetic devices for concentrating iron ores, with especial reference to Swedish practice. Two articles. 4000 w. Stahl u Eisen—April 15, 1905. No. 69736 each D.

Continuous Process.

The Continuous Steel Process in Fixed Furnaces. S. Surzycki. Read before the Iron & Steel Inst. Describes this process which can be carried out in any fixed furnace of not less than 25 tons capacity. 2500 w. Ir & Coal Trds Rev—May 12, 1905. No. 69887 A.

Dry-Air Blast.

The Application of Dry-Air Blast to the Manufacture of Iron. Discussions of Mr. Gayley's paper. 8200 w. Am Inst of Min Engrs—May, 1905. No. 69847 C.

The Application of Dry-Air Blast. (Supplementary Paper.) James Gayley. Read before the Iron & Steel Inst. Gives in detail the record of operations of the Isabella furnaces from Nov., 1904, to March, 1905, inclusive. 8000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69885 A.

The Gayley Dry-Air Blast Process (Das Gayleysche Verfahren der Trocknung des Gebläsewindes für den Hochofen). Alfred Lindner. A critical review of the Gayley process, claiming that the method is incapable of producing the results. 3500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 29, 1905. No. 69757 D.

The Gayley Dry Air Blast. James Gayley. Supplementary data to the paper on this subject presented to the Iron and Steel Inst. 2000 w. Ir Age—May 11, 1905. No. 69459.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Furnaces.

American Furnace Construction (Amerikanische Ofenkonstruktion). Bernhard Osann. Discussing especially the masonry work and refractory lining of blast and open-hearth furnaces in American practice. 3000 w. Stahl u Eisen—May 1, 1905. No. 69739 D.

Heating.

The Transfer of Heat at High Temperatures. Frank C. Wagner. Describes experiments made to determine the time required to raise plates of iron and steel to a welding temperature in an open hearth regenerative furnace. 1700 w. Trans Am Soc of Mech Engrs, No. 075—June, 1905. No. 69562 C.

Hematite.

The Clinton Hematite. Edwin C. Eckel. Gives results of a recent investigation of these ores, with analyses. Ills. 1800 w. Eng & Min Jour—May 11, 1905. No. 69508.

Ingots.

Compression of Steel by Wire-Drawing During Solidification in the Ingot Mould. Examines the cases of ingots left to shrink freely, ingots subject to compression by the Whitworth system, and by compression by wire-drawing by the Harmet system, fully describing and illustrating the last method. 8400 w. Jour U S Art—March, 1905. No. 69612 D.

Iron District.

The Iron Industry in the Minette District (Die Eisenindustrie des Minettebezirks). A tabulated view of the iron industry in the district included in Lorraine, Luxembourg, and eastern France, with map. 2000 w. 1 plate. Stahl u Eisen—May 1, 1905. No. 69740 D.

The Oolitic Iron-Ore Deposits of Lorraine. From an article by Mons. L. Bailly, in the *Annales des Mines*. Describes the deposits and the methods of working, cost, &c. 4500 w. Ir & Coal Trds Rev—April 21, 1905. No. 69350 A.

Iron Works.

The Cargo Fleet Works. Illustrations, with description of these reconstructed works which are intended to produce structural steel and to use up all the iron coming from their own blast furnaces. 3000 w. Engr, Lond—May 12, 1905. Serial. 1st part. No. 69833 A.

Lake Superior.

A Summary of Lake Superior Geology with Special Reference to Recent Studies of the Iron-Bearing Series. C. K. Leith. Description of the geology of the iron-bearing and copper-bearing series, their structure and distribution, &c. Ills. 19300 w. Am Inst of Min Engrs—Sept., 1904. No. 69842 D.

Open-Hearth.

The Influence of Carbon, Phosphorus, Manganese and Sulphur on the Tensile Strength of Open-Hearth Steel. A discussion of Mr. Campbell's paper. 2000 w. Am Inst of Min Engrs—May, 1905. No. 69848.

Water Cooled Parts for Open Hearth Furnaces. Illustrates and describes a device invented by George L. Davison and David R. Mathias. 1000 w. Ir Age—May 4, 1905. No. 69351.

Ore-Briquetting.

A Russian Ore-Briquetting Plant. Herr Zeidler in *Stahl und Eisen*. Plan and description of a plant constructed to deal with the oolitic and argillaceous brown iron ore obtained from the deposits in the Kertsch peninsula. 1800 w. Ir & Coal Trds Rev—May 5, 1905. No. 69604 A.

Recorder.

An Automatic Stock-Line Recorder for Iron Blast Furnaces. J. E. Johnson, Jr. Describes a simple, durable, and inexpensive apparatus which gives by its continuous and automatic action, accurate information concerning the stock-line for every minute of the day. Ills. 3000 w. Am Inst of Min Engrs—Feb., 1905. No. 69843.

Roasting.

The Roasting of Iron Ores (Ueber das Rösten von Eisenerzen). Oscar Simmersbach. A discussion of the effect of roasting in driving off the volatile impurities in iron ore, and an examination of the ores adapted to this treatment. 3000 w. Glückauf—April 22, 1905. No. 69747 D.

Rolls.

Roll Turning: An Important Factor in the Iron and Steel Industry. W. S. Standiford. An illustrated description of a special department of work, describing the peculiar machines and methods. 4000 w. Engineering Magazine—June, 1905. No. 69792 B.

The Calibration of Rolls for I-Beams (Das Kalibrieren der Profilwalzen für I-Eisen). Carl Holzweiler. With table giving the dimensions of passes in rolls for I-beams, and plates showing the successful reductions. 2000 w. 2 plates. Stahl u Eisen—April 15, 1905. No. 69734 D.

Slags.

Experiments on the Fusibility of Blast Furnace Slags. O. Boudouard. Read before the Iron & Steel Inst. Reports of a systematic investigation of the fusibility of silicates of lime, and of alumino-calcic silicates. Ills. 7000 w. Ir & Coal Trds Rev—May 12, 1905. No. 69889 A.

Sulphur.

The Presence of Coke-Sulphur in the Blast Furnace (Das Verhalten des Koksschwefel im Hochofen). F. Wüst and P. Wolff. An examination of the proportion of sulphur carried into the blast furnace with the coke fuel. 3000 w. Stahl u Eisen—May 15, 1905. No. 69743 D.

Sweden.

The Grangesberg Iron Mines in Sweden. J. W. H. Hamilton. Illustrated description of the methods of working, electric power being largely used, and modern appliances. 2800 w. Eng & Min Jour—May 18, 1905. No. 69802.

Tires.

The Manufacture of Railway Tires and Axles (Die Fabrikation der Eisenbahnradreifen und Achsen). E. H. Steck. A detailed description of the methods of forging and rolling weldless tires and forging car axles, with especial reference to British practice. 4500 w. Stahl u Eisen—April 15, 1905. No. 69735 D.

MINING.

Blasting.

Explosion of a Triple Mine at the Passgrub Quarry near Greifenstein (Sprengung einer Dreikammermine im Passgrubsteinbruche nächst Greifenstein). Hugo Münch. Describing the method employed for the breaking down of a large quantity of stone by chamber mines. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—April 7, 1905. No. 69725 D.

Boring.

Methods of Boring and Sinking. Treats the subjects separately, giving an illustrated description of the best known methods. 9500 w. Ir & Coal Trds Rev—May 12, 1905. No. 69893 A.

Well Sinking and Boring Appliances. An illustrated description of appliances used in boring artesian wells and bore holes generally. 3000 w. Mech Engr—May 6, 1905. No. 69584 A.

Buildings.

The Administration Buildings of the Recklinghausen Mines (Das Kauen und Verwaltungsgebäude der Zeche Recklinghausen). H. Fuchs. An illustrated description, showing the toilet and bath arrangements for the miners, care of clothes, lamps, etc., as well as business offices. 2500 w. 2 plates. Glückauf—May 13, 1905. No. 69750 D.

Colorado.

Sketch of the Economic Resources of the Foothills of the Front Range of Colorado. A. Lakes. Describes these foothills, discussing the building stones and the economics of the sedimentary beds. 2000 w. Min Rept—May 25, 1905. No. 69920.

Conveying.

Methods of Conveying Spoil at the Wilczek Mines in Polnisch-Ostrau (Mitteilungen aus der Praxis des Schlämmverfahrens am Gräflich Wilczekschen Dreifaltigkeitsschachte in Polnish-Ostrau). J. Mauerhofer. The waste spoil of the mines is carried by the flow of water through pipes to the dump. Two articles. 1 plate. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 1, 8, 1905. No. 69752 each D.

Couplings.

Deterioration of Mine-Car Couplings. Walter H. Finley. Abstract of a paper read before the Engng. Assn. of the South. Describes a case of fatigue of metals by crystallization, and the method used to remedy the trouble. 800 w. Eng & Min Jour—May 4, 1905. No. 69387.

Drilling.

Diamond Drilling Under Difficulty. S. C. Thomson. Abstracted from a paper before the S. African Assn. of Engrs.

Describes a drilling operation started at the bottom of a shaft of 2,525 ft., full of water, with no fixed guide for the drill rods in the last 95 ft. 1400 w. Eng & Min Jour—May 4, 1905. No. 69386.

Electric Driving.

Electric Driving of Stamp Batteries. L. Wilms. Gives points in favor of central station supply of power, showing that an increase in efficiency and saving in cost can be obtained. Discussion. 7000 w. Jour S African Assn of Engrs —Feb., 1905. No. 69351 F.

High-Tension Electrical Plant at Messrs. Bolckow, Vaughan and Co.'s Collieries. Illustrates and describes this plant showing the advantages and economies of the use of electricity in mines. 1200 w. Prac Engr—May 12, 1905. No. 69817 A.

Lambton Collieries Power Distribution Scheme. Gives a summary of the requirements and general conditions as shown in the specifications. 2500 w. Elec Rev, Lond—May 12, 1905. Serial. 1st part. No. 69826 A.

The Electrically Driven Semet-Solvay Coke Plant of the Wigan Coal and Iron Co., Ltd. Illustrated description of a plant the greater part of which is electrically driven. 2300 w. Elec Rev, Lond —May 12, 1905. No. 69825 A.

Explosives.

The Action of Explosives (Sprengwirkungen). C. E. Bichel. An examination of the action of various mining explosives, with table showing the volume of gas liberated, energy released, and other data. 3000 w. Glückauf—April 15, 1905. No. 69745 D.

Grinding.

Modern Crushing and Grinding Machinery. Philip Argall. Explains the writer's reasons for advocating crushing by "successive comminution." 1500 w. Eng & Min Jour—May 11, 1905. No. 69506.

Haulage.

New System of Haulage Adapted to Heavy Grades. Benedict Shubart. An illustrated description of the Morgan third-rail system. 1200 w. Min & Sci Pr —May 13, 1905. No. 69675.

Hot Springs.

Geology of the Hot Springs of Colorado and Speculations as to Their Origin and Heat. A. Lakes. Abstract of a paper read before the Colorado Sci. Soc. An interesting review of hot springs and their geological conditions, concluding that the heat is derived more from the great depth of fissures, or from latent heat, than from any direct volcanic source. 2000 w. Min Rept—May 11, 1905. No. 69565.

Lamps.

Precautions against Benzine Fires in Lamp Rooms (Sicherheitsvorkehrungen gegen Benzinbrand in den Lampenkammern). Dr. J. Fischer. Review of the official Austrian regulations concerning the filling and handling of miners' lamps. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 15, 1905. No. 69756 D.

Lead-Assay.

The Commercial Wet Lead-Assay. Discussion of paper by H. A. Guess. 1200 w. Am Inst of Min Engrs—May, 1905. No. 69852.

Leadville.

The Leadville District. A. W. Warwick. Historical notes on this district which produces silver, lead, gold, copper, zinc, iron ores and bismuth, considering some points of mining practice. 4000 w. Min Mag—May, 1905. No. 69538 C.

Mine Cars.

Mine Car Running Gear. R. V. Norris. Brief illustrated descriptions of various types of wheels and methods of lubricating. 1400 w. Eng & Min Jour—May 18, 1905. No. 69800.

Ore Handling.

Modern Ore Loading Plants and Wire Rope Tramways. Frank C. Perkins. Illustrates and describes modern systems of ore-handling apparatus, showing the great improvement and economy of methods now in use. 2500 w. Min Rept—April 27, 1905. No. 69290.

Ore Handling Plant at Conneaut, Ohio. Illustrated description of the arrangements for transferring of ore from the lake vessels to the cars or docks. The amount handled last year exceeded 4,000,000 long tons. 3500 w. Ir Age—May 25, 1905. No. 69856.

The Electric Ore Unloaders at Conneaut, Ohio. Illustrates and describes four electric ore unloaders, recently installed, for transferring the ore from ships to cars, or to storage pile. 1800 w. Elec Rev, N Y—May 6, 1905. No. 69307.

Ore Tests.

Place and Value of Small Scale Ore Tests. Ernest H. Simonds, in Trans. Cal. Min. Assn. Considers the advantages and disadvantages of each of the three general methods of making ore tests, especially discussing the method of making small scale tests in the laboratory, followed by the erection of one complete unit. 2200 w. Min & Sci Pr—April 22, 1905. Serial. 1st part. No. 69293.

Power Plants.

Economy in Operation of Coal Mine Power Plants. F. C. Weber. Presents the advantages claimed by the Corliss engine over other types of slow-speed engines for air compressors. 800 w. Mines & Min—May, 1905. No. 67404 C.

Pumping.

See Mechanical Engineering, Hydraulics.

Quarrying.

Air Power in the Quarry. Lucius I. Wightman. Describes a successful installation of a compressed-air plant at the Gray Cañon, showing that low economy is the result of careless management. 2200 w. Eng & Min Jour—May 4, 1905. Serial. 1st part. No. 69384.

Roasting.

Pyrometallurgical-Chemical Operations in Oxidizing Roasting (Pyrometallurgisch-Chemische Prozesse bei Oxydierendem Rösten). F. Janda. Reviewing the process of roasting as applied to iron, copper, lead, zinc, and other ores. Two articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—April 29, May 6, 1905. No. 69758 each D.

Sampling.

Mine-Sampling and Ore-Valuation. James Park. A discussion of methods of sampling, assaying, &c. 3000 w. N Z Mines Rec—March 16, 1905. No. 69522 B.

Shafts.

A Swinging Track. W. N. Cummings. Illustrates and describes a swinging track for shaft stations found useful in the opening of a prospect. 500 w. Eng & Min Jour—May 25, 1905. No. 69904.

Shaft Sinking by the Jetting Process. George C. McFarlane. Outlines a plan for sinking a round shaft lining, of steel jacketed concrete, provided at the lower end with a cutting shoe. Ills. 1700 w. Eng & Min Jour—May 11, 1905. No. 69590.

Signals.

An Electric Shaft Signal System (Elektrische Schacht-Signal-Anlage). F. Rüdorff. Illustrating the Siemens & Halske electric indicator and signal system, similar to the telegraph used on shipboard. 800 w. Glückauf—April 22, 1905. No. 69748 D.

Mine Bell Signals. Urges the importance of adopting a uniform code of mine signals. 2500 w. Min & Sci Pr—May 13, 1905. No. 6967[illegible]

Smelting.

The Michigan Smelter. R. T. White. Gives a ground plan of the works, describing the treatment of the ore and the methods. 2400 w. Eng & Min Jour—May 4, 1905. No. 69383.

Tubbings.

The Relative Strength of Corrugated and Ordinary Tubbings (Neues über die Festigkeitsverhältnisse Gewellter und Anderer Tubbings). Prof. Heise. An examination of the increase in resistance to external pressure in shaft linings by use of corrugated tubbings. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen —April 8, 1905. No. 69754 D.

Valuation.

The Examination and Valuation of Mines. James Park. Information for young mining graduates. Ills. 5500 w. N Z Mines Rec—March 16, 1905. No. 69521 B.

Veins.

A Lost Orebody. Harold J. Read. Illustrates a peculiar break in a rich vein caused by a series of faults. 250 w. Eng & Min Jour—May 4, 1905. No. 69385.

Ventilation.

Centrifugal Fans for the Ventilation of Mines. John Hayes. With special reference to a fan recently designed to meet colonial requirements. 2700 w. Queens Gov Min Jour—March 15, 1905. No. 69356 B.

Winding.

Caps or Attachments for Winding Ropes. W. H. Becker. Read before S. Wales Inst. of Engrs. Gives a report of tests of rope caps showing that they do not equal 50 per cent. of the breaking strain of the ropes, and gives an illustrated description of a new cap that has held a rope to its full breaking strain. 2000 w. Col Guard—May 5, 1905. No. 69591 A.

Winding Ropes.

Deterioration of Winding Ropes. Extracts from a paper by J. A. Vaughan and W. M. Epton, read before the Transvaal Inst. of Mech. Engrs. Discusses the causes and gives recommendations to ensure safety. 2400 w. Col Guard (Sup.) —April 21, 1905. No. 69332 A.

MISCELLANY.

Briquetting.

Fuel and Mineral Briquetting. A discussion of the paper by Robert Schorr. 1000 w. Am Inst of Min Engrs—May, 1905. No. 69851.

Lead.

Lead: Its Ores, Compounds and Alloys. S. Barlow Bennett. The present article reviews briefly the lead mining industry in England, and discusses the important ores of this metal and their reduction. Ills. 2200 w. Plumb & Dec—May 1, 1905. Serial. 1st part. No. 69578 A.

New South Wales.

Tin Mining in New South Wales. P. J. Thibault. A summary review covering the period from 1900 to 1904 inclusive. 2000 w. Aust Min Stand—April 12, 1905. Serial. 1st part. No. 69523 B.

Oil.

Oil and Asphaltum on the Shores of Great Salt Lake, Utah. Don Maguire. Information concerning the prospect of finding oil, asphaltum and gas in Utah, as well as in Colorado and Wyoming. Ills. 1400 w. Min & Sci Pr—May 13, 1905. No. 69676.

Oil Fields.

The Production and Use of Electricity in a Russian Petroleum Field. Frank Koester. Brief account of the application of electricity to the drilling and pumping of the wells. Ill. 1000 w. Elec Rev, N Y—May 27, 1905. No. 69900.

Quicksilver.

The Terlingua Quicksilver District. Morris P. Kirk. Brief account of this district in Texas, discovered in 1892. 1000 w. Min Mag—May, 1905. No. 69539 C.

Rare Metals.

Rare Metals and Others. J. Ohly. Considers briefly the deposits of platinum, wolframite, titanium, &c. 800 w. Min Rept—May 18, 1905. No. 69697.

Sandstone.

The Sandstone of Salesiushöhe near Ossegg, Bohemia (Der Sandstein der Salesiushöhe bei Ossegg). Hans Hofer. With description of the strata, and map and section, and a discussion of the geological conditions. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—April 1, 1905. No. 69753 D.

Sapphires.

Sapphire Fields of Central Queensland. Lionel C. Ball. Notes on their present condition. Ills. 6500 w. Queens Gov Min Jour—March 15, 1905. No. 69355 B.

Tin.

The Carolina Tin Belt. Information concerning the development and economic importance of the deposits. 1200 w. Ir Age—May 11, 1905. No. 69458.

Tin in California. H. E. West. A brief description of the work at the San Jacinto tin mines in Southern California. 2000 w. Eng & Min Jour—May 4, 1905. No. 69389.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

New Zealand.

Electric Tablet System on New Zealand Railways. A detailed report, giving the regulations governing the working of the system. 16000 w. Cons Repts—April, 1905. No. 69838 D.

Pooling.

Pooling of Locomotives. A. M. Waitt. Explains the meaning of the term, discussing the advantages to the crews and to the railroad companies, and some of the disadvantages, but generally favorable to the practice. 2500 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69429.

Switching.

Switching. F. A. Healy. A report submitted to the S. E. Accounting Conference at Nashville, Tenn., and unanimously recommended for adoption as the best system thus far introduced. 4800 w. Ry Age—May 19, 1905. No. 69666.

MOTIVE POWER AND EQUIPMENT.

Automatic Stokers.

Watching the Automatic Stoker at Work. Angus Sinclair. An account of a ride from Cincinnati to Indianapolis on an engine equipped with an automatic stoker. 2000 w. Loc Engng—May, 1905. No. 69312 C.

Brake Shoes.

The Development of the Modern Brake Shoe. F. W. Sargent. Reviews the progress since the use of wooden shoes, previous to 1850, and especially the development of the cast-iron shoe to its present degree of perfection. Ills. 4000 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69435.

Car Heating.

Heating, Lighting and Ventilation of Cars. George L. Fowler. An outline of the development and present conditions of American practice. 5000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69658.

Cars.

High Capacity Cars. Rodney Hitt. Considers briefly the development of high capacity cars and the benefits derived from their use. 3300 w R R Gaz—Vol. XXXVIII., No. 20. No. 69656.

Coaling.

Coaling Locomotives. Charles H. Fry. Reviews early practice on American railroads, and describes many types of coaling stations tried on various roads, and the modern methods finally installed. Ills. 5200 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69511.

Couplers.

Automatic Car Couplers. George Greeley. A study of these couplers, giving ideas of many mechanical and operating officials, gathered during a nine months' tour of observation, and a statement of the requirements of the modern coupler. 3000 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69510.

Couplings for Electrical Connections between Railway Cars (Ueber die Kupplung Elektrischer Leitungen Zwischen den Fahrzeugen der Vollbahnen). A. Mykish. With especial reference to the connections for electric signals and lighting on main-line trains. 2000 w. Glasers Annalen—May 15, 1905. No. 69783 D.

Dining Cars.

The Dining Car Department in America. Gives an idea of the first cost of a dining-car and its equipment, the operation and maintenance; discusses the problems to be solved to make the service satisfactory, and related matters. 1800 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69653.

Electric Traction.

On the Question of Electric Traction. M. F. Paul-Dubois. Report (No. 1) for France, on question VIII. for discussion at the seventh session of the Railway Congress. Ills. 30700 w. Bul Int Ry Cong—March, 1905. No. 69520 E.

On the Question of Electric Traction. Victor Tremontani. Report No. 4 on subject VIII. for discussion at the seventh session of the Railway Congress, for all countries, except America, France, Great Britain and Belgium. 8600 w. Bul Int Ry Cong—April, 1905. No. 69880 E.

The Electrification of Trunk Lines. L. R. Pomeroy. A study of the comparative cost of operating, and the cost of installation. 4800 w. R R Gaz—Vol. XXXVIII., No. 20 No. 69652.

Explosion.

Explosion of a Locomotive Boiler (L'Explosion d'une Chaudière de Locomotive). A discussion of possible causes for the recent disastrous explosion of a locomotive at the Gare Saint Lazare, Paris. 1000 w. Génie Civil—April 15, 1905. No. 69716 D.

Fuel.

Oil Fuel for Locomotives. Howard Stillman. Discusses the use of oil fuel, gives specifications for fuel oil as adopted by the Harriman System, the burners used, the application to locomotive fireboxes, the operation of the oil-burning locomotive, &c. Ills. 5000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69657.

Gasolene Engines.

English Gasolene Locomotives. Brief illustrated descriptions of a Wolseley light railway gasolene locomotive, and a Maudslay locomotive used for hauling freight cars. 1100 w. R R Gaz—Vol. XXXVIII., No. 21. No. 69875.

Locomotives.

A Freak Locomotive for South Africa. Illustrations and description of a combination rack and adhesion tank locomotive for exceptionally heavy grades. 900 w. R R Gaz—Vol. XXXVIII., No. 17. No. 69282.

A Historical Locomotive. Illustration, with brief description, of the first Oregon locomotive. 400 w. Sci Am—May 27, 1905. No. 69867.

A New Type of Compound Articulated Locomotive. Sections and description of two freight locomotives recently built for the Northern Railway of France. 700 w. Ry Age—April 28, 1905. No. 69280.

A Tabular Comparison of Notable Examples of Recent Locomotives. Gives table of passenger locomotives, and of freight locomotives, arranged with respect to classes and weights. Am Engr & R R Jour—May, 1905. No. 69305 C.

Common Standard Locomotives. An account of the complete locomotive standards adopted on the Harriman Lines, indicating the economical advantages. 900 w. Ills. Am Engr & R R Jour—May, 1905. Serial. 1st part. No. 69309 C.

Compound Superheater Freight Locomotive. Illustration, with brief description of an engine of the 2-8-0 type, having Cole superheaters in service on the "Soo Line" railway. 400 w. Am Engr & R R Jour—May, 1905. No. 69307 C.

Four-Cylinder Balanced Compound Locomotives. F. J. Cole. Explains the reasons which led to the use of these locomotives, stating some of their advantages, giving illustrated descriptions of many applications to different types of locomotives. General discussion. 10800 w. Pro Ry Club of Pittsburgh—Jan., 1905. No. 69378 C.

Four-Cylinder Compound Locomotives in America. F. J. Cole. Explains some of the conditions on American railroads which make this type of advantage, and reviews briefly the history of four-cylinder, balanced engines in this country. Ills. 3000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69651.

Great Western Locomotives and Their Recent Work. Charles Rous-Marten. Comments on recent changes, and on the striking features of some of the new engines is given in the present number. 2800 w. Engr, Lond—May 12, 1905. Serial. 1st part. No. 69834 A.

Locomotive Development on the Pennsylvania Railroad, 1849-1905. C. H. Caruthers. Gives diagrams to scale showing the development in size during 56 years, with notes. 1200 w. R R Gaz—Vol. XXXVIII., No. 17. No. 69281.

Maine Central Ten-Wheel Locomotive. Illustrations, descriptive specification, and notes. 600 w. Ry & Engng Rev—May 13, 1905. No. 69606.

On the Question of Locomotives of Great Power. J. E. Muhlfeld. Report (No. 2) for America, on Subject V. for discussion at the seventh session of the Railway Congress. Tables and Ills. 35000 w. Bul Int Ry Cong—March, 1905. No. 69518 E.

Rack and Adhesion Locomotives for Central South Africa. Illustrated detailed description. 1000 w. Ry Age—May 19, 1905. No. 69667.

Recent Development of the Four-Cylinder Balanced Locomotive. A. von Borries. Discusses essential points and gives suggestions of value, with comments on superheating. 3000 w. Am Engr & R R Jour—May, 1905. No. 69306 C.

Tank Locomotives. E. E. R. Tratman. Discusses the advantages and disadvantages of tank engines, giving particulars of the tank engines employed in this and other countries. General discussion. Ills. 11700 w. Pro W Ry Club—April 16, 1905. No. 69642 C.

Tank Locomotive (3-Ft. Gauge) for the Cavan and Leitrim Railway. Illustration and drawings, with brief description of an engine for very severe conditions of service. 400 w. Engng—May 5, 1905. No. 69593 A.

The Compounding of Locomotives. A. T. J. Kersey. Abstract of a paper read before the Swindon Engng. Soc. The present number considers the advantages due to compounding in marine engines, contrasting conditions of working, and discussing the considerations, and the possibilities of a condenser. 2800 w. Mech Engr—May 13, 1905. Serial. 1st part. No. 69820 A.

Reversing Gear.

Steam Reverse Gear Once on P. & R. Illustrated description of a device in use on the Philadelphia & Reading passenger locomotives before balance valves were used. 700 w. Loc Engng—May, 1905. No. 69311 C.

Speed Tests.

Comparative Speed Tests of Steam and Electric Locomotives. A report of a series of tests made April 29 over the experimental track at Schenectady, N. Y., to secure data on the relative acceleration and speed characteristics of electric and steam locomotion. 1400 w. St Ry Jour—May 13, 1905. No. 69525 C.

Steel Cars.

Gibb's Steel Railway Car. Illustrated detailed description of cars constructed for the New York Rapid Transit Subway, with remarks on the general purpose of the cars. 2000 w. Engng—April 21, 1905. No. 69338 A.

Tipping Car.

Lateral Tipping Car (Wagon à Basculement Latéral). Illustrating a sheet iron car of 15 tons capacity, arranged to tip to either side, and provided with automatic couplers. 800 w. 1 plate. Génie Civil—April 15, 1905. No. 69715 D.

Train Lighting.

A New Dynamo for Lighting Railway Trains (Eine Neue Dynamomaschine für Beleuchtung von Eisenbahnzügen). E. Rosenberg. The dynamo is especially designed to be driven from the car axle, and gives a continuous current when rotated in either direction. 2500 w. Zeitschr f Elektrotechnik—April 30, 1905. No. 69778 D.

An Improved Dynamo for Lighting Railway Trains (Eine Neue Dynamomaschine und ihre Anwendung zur Beleuchtung von Eisenbahnwagen). E. Rosenberg. Describing an improved dynamo which gives a current always in the same direction no matter which way it is run. The general application to train lighting is discussed at length. 10000 w. Elektrotech Zeitschr—April 20, 1905. No. 69767 B.

The Improved System of Electric Lighting on the Corridor Trains of the Prussian State Railways (Die Neueren Einrichtungen der Elektrischen Beleuchtung einiger D-Züge der Preussischen Staatsbahnverwaltung). Max Buttner. Showing both independent steam dynamos on the locomotive and dynamos on the car axles. Serial. Part I. 2000 w. Glasers Annalen—May 15, 1905. No. 69782 D.

The Lighting of Railway Cars. E. L. Elliott. Discusses the elements of car illumination, and the improvements in distribution that could be obtained by reflectors and the use of frosted lamps. 2000 w. Elec Rev, N Y—May 13, 1905. No. 69527.

Trains.

On the Question of Lighting, Heating, and Ventilation of Trains. Cajetan Banovits. Report No. 2 for all countries, except America, on Subject IX. for discussion at the seventh session of the Railway Congress. 7 tables. 34000 w. Bul Int Ry Cong—April, 1905. No. 69881 E.

Valves.

New Types of Valves and Valve Gears for Locomotives. Illustrates and describes the Young system, the Allfree-Hubbell system, and the Haberkorn system; three new types designed to improve the steam distribution of locomotives. 4000 w. Eng News—May 4, 1905. No. 69367.

Vestibule.

Railway-Carriage Vestibule. Illustrations of two forms of this appliance, of English make. 1300 w. Engng—April 21, 1905. No. 69334 A.

Wheels.

Cast-Iron Car Wheels. J. E. Muhlfeld. Discusses the difficulty with the cast-iron wheel as at present produced in the United States, giving results of records and tests, and concluding that the undesirable performance may be overcome, giving suggestions. 2500 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69431.

NEW PROJECTS.

Africa.

The Railways of Africa (Les Chemins de Fer Africains). A general description of existing and projected railways in Africa, with map. 2500 w. Génie Civil —April 29, 1905. No. 69720 D.

Borneo.

The British North Borneo Railway. George Cecil. An illustrated description of the line and its working, with a brief report of the commercial and civilizing results. 1000 w. Eng News—May 4, 1905. No. 69371.

Cut-Off.

The Brilliant Cut-off of the Pennsylvania R. R. An illustrated description of a cut-off built to relieve the congested traffic conditions at Pittsburg; built at a great cost, owing to the rugged country, although but three miles in length. 3000 w. Eng Rec—May 6, 1905. No. 69453.

South Africa.

Railroading in South Africa. George E. Walsh. An interesting account of the progress of railroad building, describing the country traversed, and the change being wrought by railroad transportation. 2000 w. Loc Engng—May, 1905. No. 69313 C.

PERMANENT WAY & BUILDINGS.

Electric Driving.

Electrical Equipment of a Railway Shop. Illustrates and describes the shops of the Great Northern Railway Co., at St. Paul, which were designed especially for motor driving. 5000 w. Elec Wld & Engr—May 27, 1905. No. 69917.

Electric Drive in Railroad Shops. C. A. Seley. Reviews the development of electric transmission as applied to railroad shops, the methods adopted, the systems and applications of power. Ills. 3400 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69512.

Frogs.

On the Question of Improved Rail Crossings. C. W. Buchholz. Report on subject III. for discussion at the seventh session of the Railway Congress. Plates I. to XII. 6300 w. Bul Int Ry Cong—March, 1905. No. 69517 E.

Inspection.

Permanent Way Inspection. Gives details of a new system of permanent way inspection started by the London and South-Western Railway Company. 2000 w. Engr, Lond—May 5, 1905. No. 69601 A.

Rail Joints.

New Solutions for the Rail-Joint Problem (Die Neuen Vorschläge zur Lösung der Schienenstossfrage). Fritz Steiner. With numerous illustrations of the joints used on Continental railways. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—April 14, 1905. No. 69727 D.

Thermit Rail Joints. George E. Pellissier. Describes various devices used to join rails and their degree of success, discussing both the mechanical and electrical aspects, and reviews the history of the continuous rail and the methods applied. Especially describes the method of thermit welding. 6000 w. Jour Worcester Poly Inst—May, 1905. No. 69636 C.

Rails.

Steel Rails. William R. Webster. Gives the full specifications of the Am. Ry. Engng. & Main. of Way Assn. adopted last year. 2200 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69436.

Roundhouses.

American Roundhouses and Their Operation. W. E. Dunham. Discusses the general principles observed in laying out plans for roundhouses, some of the interesting features of certain plans, the requirements, &c., 4000 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69650.

Sand Houses.

Sand Houses and Appliances. Illustrates and describes the sand driers, houses and appliances used by different railroads. 1500 w. Ry Mas Mech—May, 1905. No. 69421.

Shop Practice.

The Development of Railroad Shop Practice in the United States. M. K. Barnum. Discusses the present tendency in all shops and the improvement in equipment for securing economy and efficiency, and some of the special details. 2500 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69434.

Signals.

Automatic Block Signals. Ralph Scott. An illustrated description of the Taylor electric interlocking signal. 4500 w. Am Elect'n—May, 1905. No. 69360.

Discipline of Trainmen as Relating to Automatic Block Signals. R. G. Kenly.

Quotes cases showing that signals are not properly observed, and discusses briefly the best discipline and what it aims to accomplish. 800 w. Ry Sig Assn, Adv Paper—May 23, 1905. No. 69681.

Installation and Maintenance of Storage Battery for Track Circuits. C. C. Anthony. Gives data showing the storage battery to be well adapted to meet the requirements for track circuits. Discusses battery resistance. 3800 w. Ry Sig Assn, Adv Paper—May 23, 1905. No. 69682.

Railway Signalling in America. The present number reviews the remarks of Lord Claud Hamilton, after a seventeen days' visit in America, during which he studied railway methods, and discusses briefly the different conditions in England and the United States. 2100 w. Engr, Lond—May 12, 1905. Serial. 1st part. No. 69836 A.

Review of Signaling Since the Last Congress. B. B. Adams. A review of American and European practice during the last five years in the field of railroad signaling. 2300 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69655.

The Semaphore Spectacle. W. H. Elliott. Discusses the proper design and requirements of the frame used to hold the colored glass for night indications, and also to support the signal blade or arm. 2000 w. Ry Sig, Assn, Adv Paper—May 23, 1905. No. 69684.

Terminal Improvements.

Recent Improvements at West Milwaukee, C., M. & St. P. Ry. Illustrated description of new buildings, and installation of modern appliances. 2500 w. Ry & Engng Rev—April 29, 1905. No. 69294.

Ties.

Ties and Timber Treatment. Hermann von Schrenck. A review of the best American practice at the present time. 2800 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69432.

Train Staff.

Train Staff Operation on New Zealand Railways. Nearly full consular report, giving the general regulations and details of the system which has been in operation eight months. 8000 w. Ry & Engng Rev—April 20, 1905. Serial. 1st part. No. 69295.

Warehouses.

The Electrification of Goods Warehouses on the Lancashire and Yorkshire Railway. Brief illustrated description of the application of electrical energy to warehouses and cotton sheds to facilitate the rapid loading and liberating of wagons. 2400 w. Elec Engr, Lond—April 28, 1905. No. 69467 A.

Yards.

Progress in Yard Design. W. C. Cushing. Describes and illustrates briefly some recent work in this field, noting the extensive improvements introduced at great cost. 2 plates. 8000 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69515.

TRAFFIC.

Freight.

Freight Claims. W. A. Terry. Discusses difficulties due to carelessness of both shippers and carriers and the placing of the responsibility, and matters relating to adjustment. General discussion. 16000 w. Pro Ry Club of Pittsburgh—Feb., 1905. No. 69643 C.

Freight Trains.

The Heavy Freight Train in American Railroad Practice. George R. Henderson. Discusses the effects of overloading, giving tables showing average earnings per ton-mile, average weight of train, and average cost of haulage, &c., and the handling of heavy freight trains. 4000 w. R R Gaz—Vol. XXXVIII., No. 18. No. 69433.

Rates.

On the Question of Slow Freight Rates. W. J. Van Overbeek de Meyer. Report (No. 3) for all countries, except America, England, Italy, Spain, Portugal, France and Belgium, on subject XIII. for discussion at the seventh session of the Railway Congress. Tables. 31500 w. Bul Int Ry Cong—March, 1905. No. 69519 E.

Rate Making by Government. Hugo Richard Meyer. Discusses the problem of rate regulation, considering the American rate practices which the Interstate Commerce Commission has condemned. Concludes that the evils from government regulation would be far greater economically and more disastrous politically, than the evils which now exist. 6000 w. R R Gaz—May 12, 1905. No. 69516.

MISCELLANY.

Accounting.

Note on the Organization of the Accounts Department of the Belgian State Railways. Question XIIII. of the seventh session of the Railway Congress, following on a study of railway book-keeping generally. 38300 w. Bul Int Ry Cong—April, 1905. No. 69882 E.

France.

The Railway Situation in France. L. J. Carlier. Describes briefly the system of operation by companies under franchise, indicating how the companies are constituted, their relations with the state, and their prerogatives in commercial affairs. 2500 w. Ry Age—April 28, 1905. No. 6927[illegible]

Interstate Commerce.

Growing Sentiment for a Properly Constituted Commission. J. W. Midgley. A discussion of the need of a commission to regulate railroads, giving the views of prominent writers as well as the opinions of the writer. 2800 w. Ry Age—May 12, 1905. No. 69533.

Peru.

Railway Development in Peru. C. Reginald Enock. A brief account of extensions which will be of great advantage to the country. 1000 w. Eng News—May 4, 1905. No. 69369.

Progress.

The Progress of American Railroads in the Last Quarter Century. S. Whinery. Considers the features of progress in the period from 1878 to 1903. 3500 w. R R Gaz—Vol. XXXVIII., No. 20. No. 69654.

Spain.

The Northern Spanish Railway. Col. L. Cubillo. Illustrated description of the railway across and along the Pajares pass. 800 w. Ry Age—May 26, 1905. No. 69895.

Train Service.

Impressions of Foreign Railroad Practice. The first of a series of articles giving interesting comparison of English, French and German practice. 1500 w. Am Engr & R R Jour—May, 1905. Serial. 1st part. No. 69308 C.

STREET AND ELECTRIC RAILWAYS

Cars.

New Semi-Convertible Cars with Steel Underframes, for the Brooklyn Rapid Transit Company. Illustrated detailed description of the interesting features of construction in these new cars. 5500 w. St Ry Jour—May 6, 1905. No. 69441 C.

New Wrecking Tool Cars for Elevated Railway Service. Illustrated description of two new wrecking tool cars for the Brooklyn Rapid Transit. 2800 w. St Ry Jour—May 13, 1905. No. 69524 C.

Electric Railways.

Electric Railway Competition. Ray Morris. A study of the effect of interurban roads on short-haul passenger traffic, giving reports of conditions on various lines, and discussing questions bearing on the subject. 4500 w. R R Gaz—Vol. XXXVIII., No. 19. No. 69514.

Electric Traction.

Statistics of the Growth of Electric Traction. W. Pollard Digby. Gives statistics for the United Kingdom in regard to capital invested, mileage, &c. 1200 w. Elec Mag—April 25, 1905. No. 69614 C.

Feeders.

Feeders and Returns of Electric Tramway Systems. H. E. Yerbury. Read before the Leeds Soc. of the Inst. of Elec. Engrs. Discusses only systems supplied with power from one generating station at 500 to 550 volts. Ills. 4500 w. Tram & Ry Wld—May 4, 1905. No. 69678 B.

Freight Service.

The Electric Railroad Freight Service. H. H. Polk. Read before the Iowa St. & Inter. Ry. Assn. A general discussion of the service, its convenience to farmers, the profits to be realized, &c. 2500 w. St Ry Rev—May 15, 1905. No. 69609 C.

Heavy Haulage.

Electricity vs. Steam for Heavy Haulage. A. H. Armstrong. An inquiry into the limitations of steam locomotives, and comparing with the tests made upon the electric locomotives designed for the N. Y. C. R. R. 3500 w. St Ry Jour—May 6, 1905. No. 69443 C.

Mount Vesuvius.

The Plant of the New Electric Railroad Up Mount Vesuvius. Illustrated detailed description. 1500 w. Sci Am Sup—May 13, 1905. No. 69489.

Moving Platform.

Moving Platform Subway for New York. Discusses the project, and the decision of the Rapid Transit Commission to reserve 34th St. for a four track subway. Also editorial discussing the economies of the moving platform, and full-page illustration. 2000 w. Sci Am—May 13, 1905. No. 69486.

Operation.

Some Operative Features of the Aurora, Elgin & Chicago Railway Co. An illustrated article reviewing briefly the installation, and the changes and additions made. 4500 w. St Ry Rev—May 15, 1905. No. 69608 C.

Public Service.

The System of the Bloomington & Normal Railway, Electric & Heating Company. C. H. Robinson. An illustrated account of a company furnishing transportation facilities and also carrying on a general lighting and heating business. 1800 w. St Ry Jour—May 27, 1905. No. 69898 C.

Recording.

Diagram for Recording Overhead Data. Illustrated explanation of the method used by the Hartford Street Railway Company. 600 w. St Ry Jour—June 3, 1905. No. 70050 C.

Repair Shops.

A Departure in Repair Shop Accounting. Describes a system in which all repair work, except that required for the bare operation of cars, is done by estimate. The plan was instituted by W. E. Harrington, and has been in use several years on the S. Jersey Div. of the Public Service Corporation. 2500 w. St Ry Jour—May 20, 1905. No. 69668 C.

Signaling.

Signaling in the Subway. J. M. Waldron. Describes this very successful system of block signaling and the care given it to keep it in perfect order. 2500 w. Ry Sig Assn, Adv Paper—May 23, 1905. No. 69683.

Single-Phase.

Car Equipment of the Indianapolis & Cincinnati Traction Company. Illustrated description of the cars of this single-phase line. 1100 w. Ry Age—June 2, 1905. No. 70045.

The Stubaital Single-Phase Railway. Illustrated detailed description of this single-phase current railway in Austria. 1100 w. Elect'n, Lond—May 5, 1905. No. 69589 A.

Sprinklers.

Sprinkler Test in Cleveland. A summary of tests made to determine the value of this system of fire proctection. Ills. 1400 w. St Ry Jour—June 3, 1905. No. 70047 C.

Storage Yard.

A New Storage Yard and Shop Plant for the Brooklyn Transit Company. Illustrates and describes the yard under construction for the accommodation of the elevated and surface lines of the eastern district of the city. 2500 w. St Ry Jour—June 3, 1905. No. 70048 C.

Trolley Wires.

Overhead Accidents and Their Prevention. Discusses the risks from defective design or construction, defective maintenance and from lack of foresight. 2000 w. Elec Rev, Lond—May 5, 1905. Serial. 1st part. No. 69587 A.

Valtellina.

An Electric Locomotive with Coupling-Rod Drive. Illustrated description of new electric locomotives for the Valtellina line in which the motors are mounted on independent shafts carrying a crank at each end, and actuate the driving wheels by means of coupling rods. 1500 w. Eng News—May 1, 1905. No. 69368.

New Electric Locomotives on Italian Railways. Frank C. Perkins. Illustrated detailed description of high power alternating current electric locomotives recently placed in operation on the Valtellina three-phase electric railway. 3000 w. Ry & Engng Rev—May 20, 1905. No. 69694.

The New Electric Locomotives for the Valtellina Railway (Les Nouvelles Locomotives Electriques des Chemins de Fer de la Valteline). Illustrated description of the 62 ton, three-phase locomotives recently put into service on the Valtellina railway in Northern Italy. 2500 w. 1 plate. Génie Civil—April 22, 1905. No. 69717 D.

The Valtellina Railway. An explanation of the conditions that led to the adoption of electric locomotives for this line, with much interesting information in regard to tests made and their general working; also a report of the working costs. 2600 w. Engr, Lond—May 5, 1905. No. 69596 A.

The Valtellina Railway. E. Cserhati. Discusses the working costs and test figures obtained with three-phase traction. 3500 w. Elec Engr, Lond—May 5, 1905. No. 69585 A.

Vienna.

The Street Railways of Vienna (Die Städtischen Strassenbahnen in Wien). Gustav Wärmer. A very complete account of the electric tramway system of Vienna, showing the growth during the past ten years. 5000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—April 22, 1905. No. 69759 D.

Walthamstow.

The Light Railways of Walthamstow. Gives briefly the history of the undertaking, with an illustrated detailed description of the tracks, overhead equipment, generating station, &c. 5500 w. Tram & Ry Wld—May 4, 1905. No. 69677 B.

Wheels.

Wheel Grinding on the Boston Elevated Railway. Explains the methods of maintaining wheels, the wear upon passenger cars being so great that the wheel has to be ground every two weeks. Ills. 2000 w. St Ry Rev—May 15, 1905. No. 69607 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

olliery Guardian. *w.* London.
ompressed Air. *m.* New York.
omptes Rendus de l'Acad. des Sciences. *w.* Paris.
onsular Reports. *m.* Washington.
eutsche Bauzeitung. *b-w.* Berlin.
omestic Engineering. *m.* Chicago.
lectrical Engineer. *w.* London.
lectrical Magazine. *m.* London.
lectrical Review. *m.* London.
lectrical Review. *w.* New York.
lectrical World and Engineer. *w.* New York.
lectric Club Journal. *m.* Pittsburg, Pa.
lectrician *w.* London.
lectricien. *w.* Paris.
lectricity. *w.* London.
lectrochemical and Met. Industry. *m.* New York.
lektrochemische Zeitschrift. *m.* Berlin.
lektrotechnische Zeitschrift. *w.* Berlin.
lettricita. *w.* Milan.
ngineer. *w.* London.
ngineer. *s-m.* Chicago.
ngineering. *w.* London.
ngineering and Mining Journal. *w.* New York.
ngineering Magazine. *m.* New York & London.
ngineering News. *w.* New York.
ngineering Record. *w.* New York.
ngineering Review. *m.* London.
ng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
ar Eastern Review. *m.* Manila, P. I.
ire and Water. *w.* New York.
oundry. *m.* Cleveland, U. S. A.
énie Civil. *w.* Paris.
esundheits-Ingenieur. *s-m.* München.
iorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
laser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
ce and Refrigeration. *m.* New York.
ll. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
ngenieria. *b-m.* Buenos Ayres.
ngenieur. *w.* Hague.
nsurance Engineering. *m.* New York.
ron Age. *w.* New York.
ron and Coal Trades Review. *w.* London.
ron and Steel Metallurgist. *m.* Boston.
ron and Steel Trades Journal. *w.* London.
ron Trade Review. *w.* Cleveland, U. S. A.
our. Am. Foundrymen's Assoc. *m.* New York.
ournal Asso. Eng. Societies. *m.* Philadelphia.
ournal of Electricity. *m.* San Francisco.
ournal Franklin Institute. *m.* Philadelphia.
ournal of Gas Lighting. *w.* London.
ournal Royal Inst. of Brit. Arch. *s-qr.* London.
our. Roy. United Service Inst. *m.* London.
ournal of Sanitary Institute. *qr.* London.
our. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
ournal of the Society of Arts. *w.* London.
ournal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
our. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
ournal Western Soc. of Eng. *b-m.* Chicago.
ournal of Worcester Poly. Inst., Worcester, U.S.A.
ocomotive. *m.* Hartford, U. S. A.
achinery. *m.* New York.
adrid Cientifico. *t-m.* Madrid.
arine Engineering. *m.* New York.
arine Review. *w.* Cleveland, U. S. A.
em. de la Soc. des Ing. Civils de France. *m.* Paris.
étallurgie. *w.* Paris.
inero Mexicano. *w.* City of Mexico.
ines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Engineering Papers.

The Principal Professional Papers of Dr. J. A. L. Waddell. Edited by John Lyle Harrington. Size, 9 in. by 6 in.; pp. ix, 992. Price, $5.00. New York: Virgil H. Hewes.

In the course of a professional career of a wide and varied nature Dr. Waddell has given to the engineering profession many valuable and interesting papers, but in most instances these have reached but limited audiences, or have been buried in the transactions of the professional societies before which they were presented. The collection of these writings into a volume of handsome appearance and convenient form is a real service to both the practicing engineer and to the engineering student.

The wide variety of subjects treated renders it impossible to examine the papers in detail, but attention may be directed to those upon the subject of engineering education, and those upon the design of bridges and other structural works. The part which has been taken by Dr. Waddell in engineering education in Japan renders his address to the Japanese Engineering Society of especial interest in view of the developments which have occurred since that time.

An important feature in the work is the fact that such of the papers as were presented before professional societies have the discussions which they elicited appended to them, this giving, in many instances, a most useful expression of opinion of other eminent engineers upon the subjects treated. Engineering literature has not many works of this kind included in it, and as a contribution to the literary, as well as the professional department of applied science it is to be welcomed and appreciated.

Marine Engines.

Marine Engines and Boilers, Their Design and Construction. By Dr. G. Bauer. Translated by E. M. Donkin and S. Bryan Donkin. Edited by Leslie S. Robertson. Size, 9 in. by 6 in.; pp. viii, 772. Price, 25s., $9.00. London: Crosby Lockwood and Son. New York: The Norman W. Henley Publishing Co.

The important position held in Germany by the treatise of Dr. Bauer upon the design of marine engines and boilers renders a translation of the work an occasion for congratulation both to the translators and editor and to the marine engineering profession. Time was when Germany looked to other nations and languages for works of this character, but with the development of German shipbuilding there has grown up a mass of technical literature embodying the experience acquired both at home and abroad, and dealt with in the spirit of German thoroughness which is fully appreciated in England and America.

The successive chapters include discussions of the main engines, in arrangement and in detail; of auxiliary machinery, with especial reference to the pumps for all departments of service; of shafting, resistance of ships, and propellers; and of piping and its arrangement and connections. A separate section is devoted to marine boilers, including the cylindrical, locomotive, and water-tube types; following which are chapters on measuring instruments, minor details, and useful tables. To this translation there has been added the final report of the committee on naval boilers, made to the Lords Commissioners of the Admiralty in June, 1904.

This work is undoubtedly the latest and most complete treatise on the subject of the machinery of steamships which has yet been made, and as such it will doubtless find a place in the working library of the naval constructor and engineer.

BOOKS RECEIVED.

Builders' Hardware. By Henry R. Towne. Price $5.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Diary and Engineering Data for Electrical and Mechanical Engineers. Westinghouse Electric and Manufacturing Co., Pittsburg, Pa.

The Naval Constructor. By George Simpson, M. I. N. A. Price $5.00. New York: D. Van Nostrand. London: Kegan Paul, Trench, Trübner & Co.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

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THE HIGHER LAW IN THE INDUSTRIAL WORLD.

"And we must take the current as it serves or lose our ventures."
—SHAKESPEARE.

By H. F. J. Porter.

Mr. Porter restates very effectively the proposition which is making headway too slowly among manufacturers and other employers—that it actually pays, in money and time, to treat employees with a high degree of consideration and sympathy, as well as with careful justice and fair dealing. The statement in this instance is forceful not only by the manner in which it is put, but because it is supported by recent, practical, and successful trial, and indeed is the record of actual results under working conditions.—THE EDITORS.

WHEN one man wants another who is considered an expert in his specialty to work for him at his most reasonable rate of pay, it might be supposed that the most natural way to go about it would be to lay before him in as glowing terms as possible the advantages to be obtained by accepting his proposition over any others that may be made to him. He should depict the attractive surroundings, the cheerful conditions, the pleasant associations connected with the situation, and the abundant facilities for doing good work which would be accorded his acceptance.

Then, after the expert had come to work, it would seem to be natural to arrange that everything which was held out to him as an inducement should be provided, in order that he should be satisfied and contented with his place. It would seem as if it might be a good idea to keep in touch with him regarding his needs and to furnish him with whatever was deemed necessary to perfect his work. It would also seem natural, especially if the work required a considerable length of time to finish, so that the expert's services would be desired permanently, to enter into some close relations with him, not only of a financial but also of a friendly nature, so that his interest would be continuously enlisted in his work and he would not become dissatisfied with his prospects.

If, then, the conditions and relations above described are natural, or in other words, those which human nature expects and demands in order to secure hearty co-operation, why is it that when a man wants more than one expert to work for him continuously, as is the case in the many thousand industrial enterprises throughout the world, he does not naturally extend to these employees collectively the same treatment as he would to the single expert? In this connection it should be realized that in the specialization process which competition has brought about in recent years, employees, no matter how small and apparently insignificant their special operation, are to be considered in the light of experts. Why does the manager then, as a rule, herd these expert employees in dark, ill-ventilated work shops, provide them with poor facilities for doing their work, and offer them few or no comforts? With not only an absence of personal touch, encouragement, and effort to inspire interest in their work, but with the introduction of conditions which induce discouragement, fear of loss of position, and anxiety of mind lest bad workmanship of others may be charged to them and their wages cut proportionally without recourse to some arbiter of justice, will human nature on the part of the employee respond with cordiality to the full expectations of the employer? Certainly not. There is much simplicity in the attitude of mind of one who expects enthusiastic interest in his affairs to be displayed by his workmen when he openly shows that he takes no interest in them. Why are managers so short-sighted as to allow conditions to exist whereby they cannot expect to secure the best efforts on the part of their employees? One reason may be found in the inability to break away from tradition. Only as far back as twenty-five or thirty years ago, the owner and manager of an enterprise was himself better informed, of wider experience, and possessed higher mechanical skill than any of his workmen. He knew little or nothing of shop organization, but he and his men worked together with most intimate and cordial relations. He called his men by their first names and was their friend and adviser.

The manager of the present day, however, owing to the changed conditions of the times, himself seldom possesses any mechanical ability; and yet, owing to the traditions surrounding his title, he feels that he must pose as if he knew every detail of the business. In the larger enterprises of the day, where many hundred men are employed, even the superintendent is selected, not because he is an expert mechanic, but on account of his knowledge of shop organization and management; and sometimes his foremen fall into the same category. The shop organization is framed on the military plan, with the employee in the ranks as the only expert in execution of the work actually in hand. In a military organization there is no touch between the commander-in-chief and his men. They are not allowed to think, but are expected merely to carry out what he has planned.

In the change from the old to the present system of management, the close touch between manager and operative has been lost, and with it much of the spontaneous helpfulness which accompanied the older methods. When, however, methods, are not natural, when numbers of men are governed by a system which does not bring from them the response which they ought to give freely, then it must be recognized that something is at fault, and either that which is missing must be supplied or a new system substituted. To show that this is not mere theorizing, it is only necessary to refer to the concerns that stand at the head of their respective industries, such as Fried. Krupp in Germany in steel; Cadbury's chocolate manufactory, and Lever Bros., Ltd. soap works, both in England; Marshall Field and John Wanamaker, the National Cash Register Co., in the United States, and many others, every one of which has realized the importance of appealing to the human element in its organization and by proper recognition and treatment turned it to account.

The methods adopted to bring about this betterment of industrial conditions vary considerably according to the circumstances affecting each individual enterprise, but the foundation in every case must be purely ethical, and the basic principles of right action must be strongly instilled into all its members in order to accomplish the desired result.

From my own experience of many years as a student of methods of industrial management, sometimes as an interested participant and at others as principal in introducing systems of organization, I have thoroughly convinced myself that all companies will pay their projectors better if they recognize the importance of securing the benefits that will accrue from utilizing and improving the intelligence which the employees possess. Some companies which have not paid may be so improved as to be considered successful enterprises by the accession of the brains of the working elements. An instance of this kind is fresh in my mind. The concern, operated under the ordinary system of management, had made two ineffectual efforts to market its product. By securing the enthusiastic co-operation of the working forces the latter were soon doubled in number, the company was put on a paying basis in a very few months, and at the end of the first fiscal year realized a fair interest on capital invested.

Because of the resulting satisfaction to all interested, not only in this, but in every similar case which has to come to my attention, I feel that it is my duty to add to the testimony of those who have closely studied the working of the law of cause and effect as applied to the industrial situation—that not only do companies succeed which have adopted ethical methods of management, but they succeed *because* they have adopted them. This fact should be of interest to managers generally who are struggling with what seems to be a great problem in the industrial field, viz., the establishment of such relations between employees and employed as will effect the best results commercially and at the same time benefit all concerned. I presume that to those who are so interested, the ways and means of introducing these methods will appeal, because as far as I am aware, no such account has been recorded. In this article I am therefore responding to the many requests which have been made during the past few months to describe the principles which have been applied in the reorganization of companies, and the methods of applying them, so that they may be considered by the managing class in general and so much as is available in any case can, if desired, be adopted.

In the first place, however, it must be plainly stated that there is an educational phase to the situation. Although the principles underlying ethical methods of management are perfectly logical, still managers find it so much easier to follow custom than to comply with the exactions of logic that they actually hesitate to follow the dictates of their reason. For instance, before anything can be accomplished by a concern which evinces a desire to advance along modern lines, the following ideas must be strongly indoctrinated throughout the entire organization:—It must be recognized initially that if one man autocratically domineers the organization, its scope of expansion can never be any greater than what could be devised by himself. Also, that the character of work that may be realized from the organization as a whole will be no better than can be produced by the individuals that compose it. That if honest workmanship is desired honest workers will be necessary for its accomplishment; if rapidity in production of output is expected, skill and enthusiastic devotion to duty will have to be possessed by the operatives; if improvement is to be hoped for in methods and processes and perfection of product expected, the workers must possess intelligence and suitable opportunities for its expression; if the organization as a whole is expected not to stand still, but to grow not only in size but in strength and character, facilities must be offered for the improvement of the individuals and inducements made for taking advantage of them; if untiring aggressiveness against competition is desired, absolute confidence in the enterprise and its product will have to be infused throughout the organization; and if harmonious co-operation between departments and management is to be effected, a spirit of mutual helpfulness must be imbued in the individuals comprising them respectively.

To accomplish all of this there is necessary only a change of attitude from one of force on the part of the management and resistance on the part of the workers, to one of "getting together" for a common purpose. In the atmosphere thus created the idler and the antagonist find themselves uncomfortable and either "get in line or get out." In other words, the situation presents a simple problem of cause and effect, the solution of which lies in establishing certain definite conditions, the results of which can be closely pre-determined. Methods which repeatedly verify themselves are scientific, and in this respect ethical methods as here applied deserve that appellation.

Presuming that the management is in a receptive frame of mind and sincere in its desire to adopt such principles as have been outlined above, it is ready to proceed with their application according to well defined lines; but it will depend upon the relations already existing between management and employee as to how long it will take to establish confidence in the attitude which the management is taking, which confidence is essential to the succesful development of the new methods.

In order to have a concrete case before us, I will refer to that above mentioned, which is typical of what may be found anywhere about the country, viz., a factory engaged in manufacturing electrical supplies in the center of a large city. One hundred and fifty employees equally divided as to sex. The ordinary type of management—employees hired, given a check number, worked all day, went no one cared where after leaving the shop at night.

The first thing done was the development of a chart showing the relations of the officers and departments to each other. Relations between members of the organization are undefined without a chart, but as soon as one is made, each individual in the organization knows exactly where he stands and what his specific duties are. Blue-print copies of this chart were posted on bulletin boards which had been distributed throughout the factory, at least one in each department.

Shortly afterwards, a factory meeting was called at noon time and all employees from the highest to the lowest were requested to attend. At this meeting, the writer stated that the company desired to change its method of management to one in which all the employees would have a voice. A simple explanation was given of the principles which were to govern. It was made plain that the success of the company must necessarily be dependent upon the reputation of the product in the minds of the public, and that that reputation could be made and sustained only by putting the best material and workmanship into that product. The company would guarantee to furnish the best material obtainable, but there was needed the help of the working organization to see that the best workmanship would be supplied. The company intended to pay the best wages, and it would adopt such a wage system that those who chose could add to their earnings up to the full extent of their ability. Opportunity would be given the employees to suggest any improvements, either in conditions affecting their comfort, in methods and processes of manufacture, or in design of product; and every suggestion leading to increased efficiency on the part of the employee or to the benefit of the company, would be accepted and generously paid for. An opportunity would also be given any employee to advance in the organization as rapidly as his capability would allow, and encouragement would be offered and facilities presented to advance from the factory into the office and selling organization.

The organization was requested to elect a permanent "factory committee" composed of representatives from the clerical force in the office, from the operatives in the factory, and from the foremen. After election lots would be drawn regulating the terms of service of those on the first committee, so that one member would drop out each month and a new member to serve for six months would be elected. In this way by a monthly change of one member only the personnel of the committee would never be seriously affected. The company would be represented in the committee by the superintendent of the factory who would remain as its permanent chairman.

There are always matters arising in every shop which employees desire to bring to the attention of the management. Sometimes through the scarcity of leaders in whom they might have confidence these matters go by default. At other times committees are formed hurriedly and therefore such matters are not intelligently presented. Here, however, was as representative a committee as could be obtained ready at all times to consider such matters and to pass upon them intelligently for recommendation to the management, and a channel of intercommunication between management and employee continuously existed. The employees were requested to take a few days to consider the situation, which was of course entirely new to them, before proceeding to elect their representatives on the committee, in order that their selection should be of a type that would be both capable and responsible.

As soon as the committee was formed, the "suggestion system" was installed. The equipment for this consisted of small locked boxes distributed throughout the factory and the offices. The boxes were simple affairs with a slit in the top through which communications containing suggestions could be dropped. Each suggestion had to be signed by the author and enclosed in a sealed envelope addressed to the committee, otherwise it would not be considered. The committee considered the suggestions in turn, referring them to whichever department they affected provided they could not pass upon them unassisted. The action of the committee on each suggestion was embodied in the minutes of the meeting, which were typewritten in multiple and posted on the official bulletin boards in the factory and forwarded to the district sales offices. There were two sources of suggestions, viz., (1) the factory, (2) the salesman, and the suggestions, although classified, were not necessarily limited to the classification.

A schedule of awards for all suggestions which were recommended by the committee to the management for adoption was arranged in advance, and rules promulgated so that foremen would encourage their employees to think for themselves and suggest ideas which they felt would lead to improvement in the various directions scheduled. To prevent foremen suppressing suggestions, awards were made to those from whose departments the greatest number of suggestions originated, and if there seemed to be a lagging of the supply from a department at any time, its foreman was promptly called to account and urged to stimulate his employees to further initiative. Sometimes a suggestion would be made, which although totally unavailable would contain a latent idea which someone else would seize and utilize in other suggestions which would be practicable. In a very short time employees who were experts in their work, which perhaps consisted in repeating a simple operation many hundreds of times daily, sent in suggestions which sometimes saved considerable expensive material, or even eliminated the operation altogether. In cases of the latter class, besides paying exceptionally well for the suggestion, the operatives were put at other work and encouraged to develop their capacity for initiative further. They were considered the kind of people it was desirable to keep. Salesmen soon forwarded suggestions, made primarily perhaps by some customer and modified and made practical by themselves. In a very few weeks the experimental department was crowded with work making the ideas thus received effective. The cost of manufacture was considerably reduced, and not only was the standard product perfected so as to meet the demands of the public, but new lines were successfully launched.

Here was shown the working of the law of cause and effect. The company had long possessed the intelligence of many minds which had never been allowed to develop and express itself. As soon as the opportunity was offered, and each operative found that it would be not only perfectly safe to offer a suggestion which would even at first glance deprive him or her of a livelihood, but that such a suggestion would lead to instant remuneration and to more profitable occupation, there soon blossomed in an apparently barren field a rich crop of ideas. Of course there was some chaff in it, but the machinery existed in the factory committee to separate it, and the conversion of the crop into money was accomplished only as rapidly as the company chose to spend the money for the purpose.

The spur thus given to the ambition of the individual soon gave evidence of the awakening of a desire to improve in knowledge in order to advance. Many employees entered correspondence and night schools. A clerk in the correspondence department started an evening class of stenography and typewriting at a nominal sum per head, but which netted her a neat little sum per week. Another in the financial department likewise offered his services as teacher of a class in book keeping in the evenings, and there was a general uplift to the whole situation. Several social and other organizations were formed among the employees—notably a Musical and Dramatic Association, a Literary Club, a Camera and Sketch Club, an Athletic Club, and a Mutual Aid Association.

Preference was always given, other things being equal, to an employee whenever a vacancy developed in any department. It was understood, however, that no one would be promoted from the factory unless an understudy was ready to fill the vacancy thus occurring. In this way ideal conditions were established for improvement and for helpfulness which most excellently served their purpose. The recruiting of a sales organization offered a special opportunity to inspire the ambition of the individual in the factory organization to advance. A school was established for thoroughly equipping prospective salesmen

SALESMEN'S SCHOOL AT THE FACTORY, IN SESSION.

for their duties, the instructor being a college graduate with the degree of Electrical Engineer who had advanced to the sales department from the experimental section of the factory. Arrangement was also made so that the students could take a course of instruction by correspondence in some of the schools of salesmanship which are doing excellent work about the country. The knowledge of the product, possessed by salesmen who had developed from the factory, established a confidence in it which no amount of hearsay evidence could have produced. No matter what objection was raised against it by prospective purchasers, the salesmen were never at a loss for knowledge to refute it if untrue, or to overcome it if true.

The fact that the sales offices of the company, scattered about the country, were supplied with people who were once in the factory, developed ties of mutual helpfulness toward a common aim. The interdependence of the two departments was brought home to each at every return of the traveling element to the factory; and on the semi-annual meetings of the district sales managers at the factory the home organization extended a royal welcome through their social organizations, in the winter by a musical and dramatic entertainment and a dance, and in the summer by a picnic, with athletic sports. It was on these occasions that the semi-annual distribution of awards for suggestions was made.

THE EMPLOYEES' ANNUAL MIDSUMMER PICNIC.

It was interesting as well as gratifying to see how willing outsiders were to help these people to help themselves. Some employee suggested that it would be a good thing to have some lectures in the factory building from time to time in the evening during the winter months. A sub-committee was appointed by the factory committee and a course of lectures by some of the most representative people in the city was the result. A nominal fee was charged for attendance at these lectures. This fee was devoted to the support of the band, which was part of the "Musical and Dramatic Association" and was always a prominent feature, both before the lecture in rendering several pieces of high-class music and afterwards to accompany a reception and dance lasting for about an hour, during which the employees enjoyed meeting the speaker of the evening and other guests who might be present. The piano belonging to the band was kept in the girls' dining room and was enjoyed by them every day at luncheon.

Tickets were sent by several outside societies in the city admitting to their lectures, musicales, art exhibits, etc., as many as could attend. Another sub-committee which was requested to procure reading matter for the employees was promptly advised by the local Carnegie Library that a branch of that institution would gladly be installed in the factory building.

The health of his employees should be of primal importance in the thought of the manager. No one can work at his best when he is not well. No work can be good when performed by some one who is ailing. There is besides a depressing effect upon others caused by the presence of one who is not in health and naturally complaining. Much of the ill health of the general run of people comes from eating food which is not wholesome, from eating too fast and from lack of exercise. Most of the indisposition of the employees was traceable to indigestion, which they were accustomed to alleviate by recourse to patented nostrums. Advice given by the physician and the matron regarding diet not only improved the physical as well as the mental condition of the force, but raised the average attendance at the factory very considerably. The Mutual Aid Association proposed primarily to provide the attendance of a physician in case of sickness and the payment of a stated sum of money during that time. Its best work, however, was directed towards preventing illness through a course of lectures by the physician given to the employees on "How to Keep Well," and through his collaboration with the matron, who ministered to their temporary ailments.

THE GIRLS' LUNCH ROOM.

GIRLS' REST ROOM.

The lack of exercise showed its effect on the operatives especially during the winter time just after noon hour when they would resume their work. It was very noticeable that for some time it would be difficult for many of them to stay awake, and this hour was not a profitable one for the company. When the men of the organization appreciated how little exercise they obtained owing to the sedentary nature of their occupation, they joined the Athletic Club, which then petitioned the management for space (of which there was plenty in the factory building) in which to instal some gymnastic apparatus for use at noon and in the evenings. The money to purchase this they themselves arranged to provide.

Worry over family and other troubles is another source of ill health. Information promptly reached the management through the matron when family conditions were distressing an employee, which a helping hand at the right moment could relieve. Close ties were thus formed which linked the employee and employer together and served to develop the spirit of loyalty which is an invaluable possession.

Some managers say that they are not interested in knowing what their employees do outside of working hours. Some employees say it is none of the manager's business to know what they do in their own time. "When," however, as old Gorgon Graham says, "what the employees do in their time affects what they do in the employer's time" then it may be to his interest to make it his business to look into such matters. When this is done with a spirit of helpfulness the employer welcomes it, barring him who wastes his time and money in a way to render himself unfit mentally and physically for good work; and for his opinion regarding the employer's methods the latter does not cherish a very high regard. It should be remembered, however, that in every factory organization there are apt to be many operatives who, because they are strangers in the locality or from reasons consequent to their condition and circumstances, have no opportunities for social recreation and pleasures and no places to go after working hours, and therefore, being more or less the creatures of circumstances, drift into associations and habits which may be debasing in their tendency. This sort of thing leads either to a lowering of the status of the organization, if they remain in it, or to an unsettled state, if there are many changes due to constant removals. The social instinct in man causes him to seek companionship, and if opportunity is given the members of the organization to attend lectures and other meetings which are attractive and at the same time elevating in their tendency, the whole fabric of the organization becomes homogeneous and remains intact.

The character of the individual should be a no less important consideration in the mind of the employer than his health. It is very necessary to know whether or not the employee can be relied upon in the quality of his workmanship and in his effect upon others in the organization. In fact, health, character, and education are the factors in the make-up of the employee which must receive the serious consideration of the employer, and their relative importance is shown by the order in which they are named.

DINNER TO DISTRICT SALES MANAGERS AT THE OFFICERS' CLUB

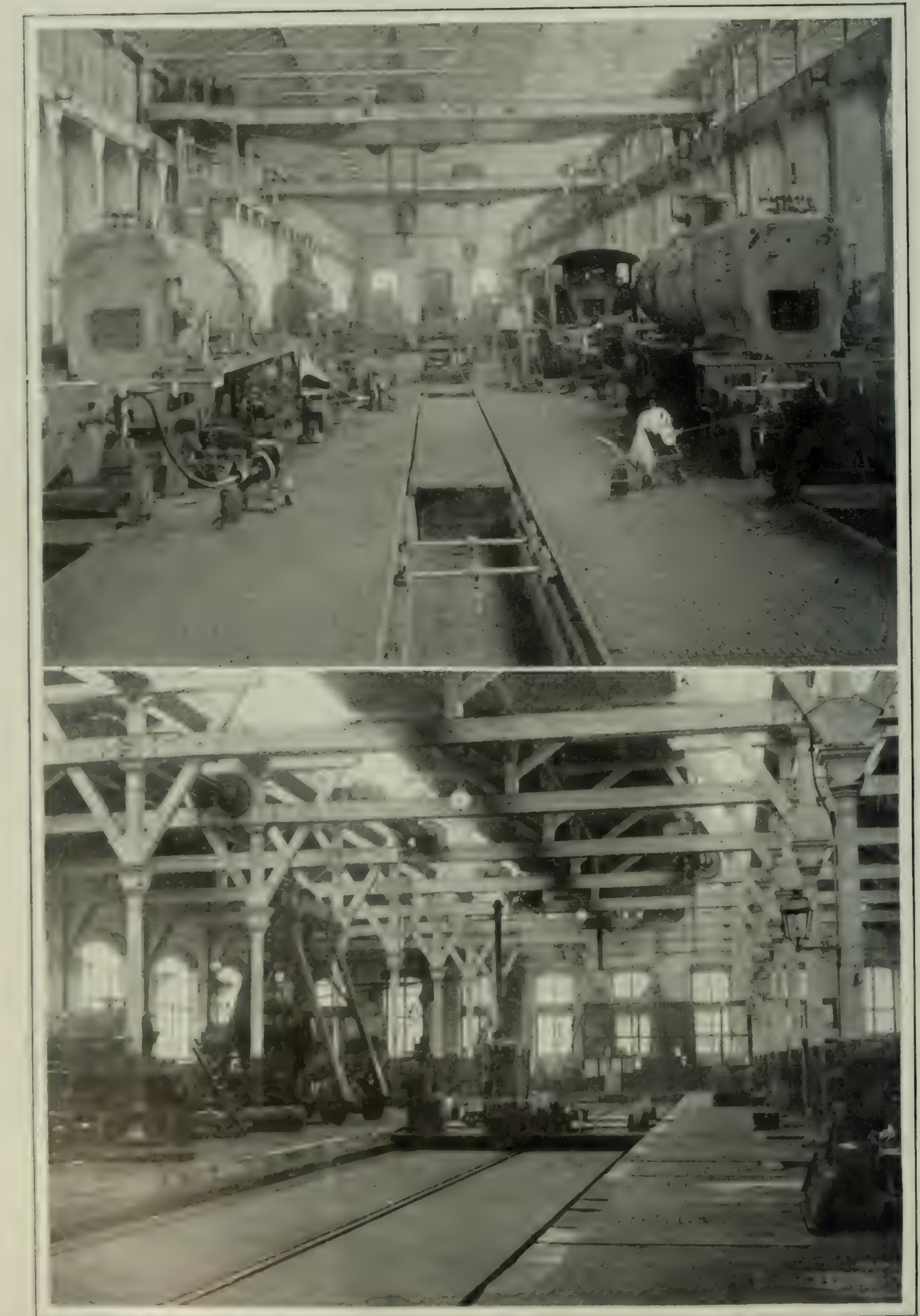
It has already been said that in order to secure the best quality of work the mind of the worker must be as free as possible from distracting thoughts. Peace of mind cannot be maintained while conditions exist which entail loss of employment, reduction of wages, nagging by foremen influenced by favoritism, unpleasant or unhealthful surroundings, ineffective facilities for service, etc. Not least

GROUP OF EMPLOYEES WHO PARTICIPATED IN THE MIDWINTER MUSICAL AND DRAMATIC ENTERTAINMENT.

among thoughts which are disturbing in their nature are those which include fear of danger from accident. Laws have been enacted making certain safeguards obligatory. Besides the ordinary precautions demanded by law, however, there are moral obligations which are equally mandatory. Statistics show that in case of fire more fatalities result from panic due to fright than from the fire itself. To the manager who is mindful of the interests of his company, his employees, and the community, it therefore becomes necessary not only to comply with the law compelling the provision of fire escapes, water buckets, standpipes, hose, fire extinguishers, etc., but to assign to certain people the duty of keeping this apparatus in serviceable condition and to drill them in its use. The practical efficiency of a complete fire drill has been so repeatedly demonstrated that public opinion, through its medium, the press, is now demanding that laws be enacted compelling factories to adopt it. The housing of many human beings in a factory building should entail the responsibility of their protection and ensure their safety in case of fire. In the factory in hand the fire drill was inaugurated, and the very first exercise developed the absolute impracticability of the type of fire escape provided. The first whistle, through mental association with sudden danger, at first caused some of the girl employees to faint from fright. This feeling was soon overcome, however, and complete drills were enacted without any excitement whatever. Occasional repetition of the drill reduced the time of exit from the building from more than seven to less than three minutes, a saving in time which would in case of fire be the cause of preserving many lives.

It must be evident to the veriest tyro in management that unless the employees are made to realize that the company feels an interest in their welfare, they cannot be expected to display a kindred feeling towards the company. The methods here introduced, however, furnished an incentive on the part of the employees to give to the employer the best there was in them, and not only during working hours but at all times, the forces of personal interest, enthusiasm, and individual capacity were directed towards the welfare of the company.

Pressure was at times brought to bear on the company to advertise what it was doing in the nature of industrial betterment. This was always resisted on the principle that one should not advertise the fact that he is doing simply what is right. The employees spoke to their friends of how they were treated, and the list of applications for positions by the very best class of employees from other factories, not only in the neighborhood but at a distance, was a long one. Employees are not slow to learn where they will receive the greatest benefit and they promptly seek that place. As the system became established, the undesirable element among the employees retired in the face of the pressure from outside of others more worthy, and through this change the whole organization awoke from a sullen stupor into a sentient being full of life and feeling. It was the intelligence and vital force of this organism that put the company on a paying basis, testifying to the efficiency in the industrial world of the ethical laws that "right makes might."



THE ERECTING SHOPS OF THE "EST" RAILWAY AT EPERNAY, FRANCE.

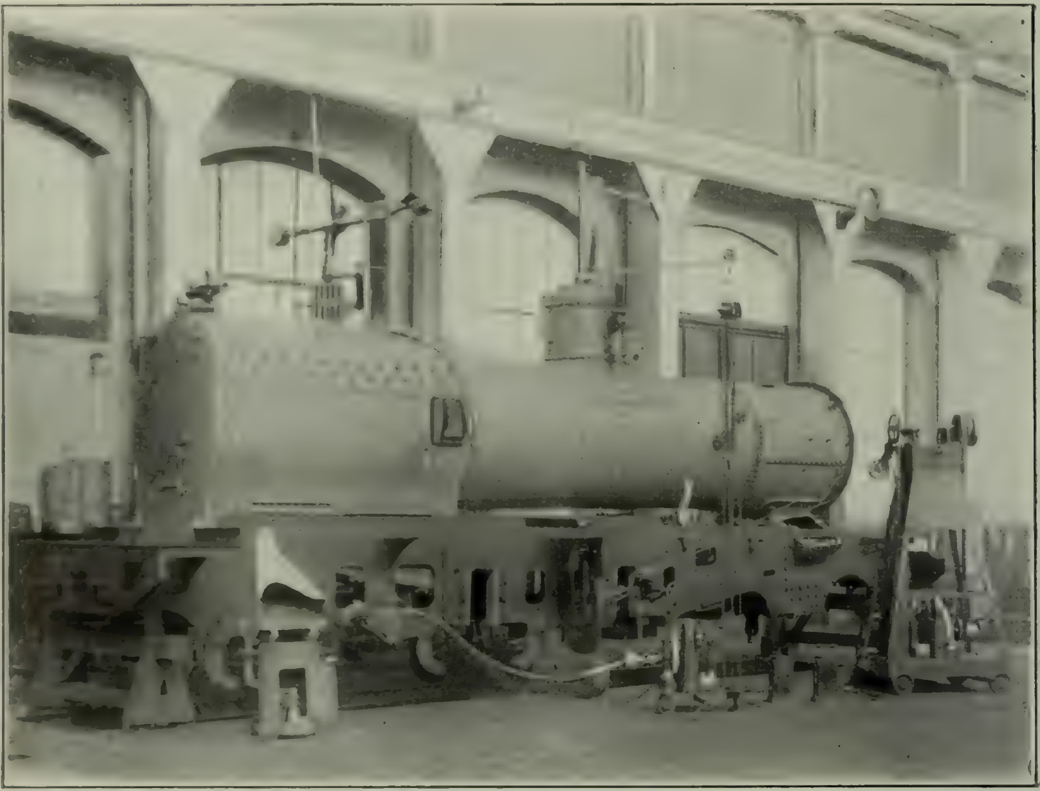
A LARGE LOCOMOTIVE BUILDING AND REPAIR WORKS IN FRANCE.

By Charles R. King.

Mr. King's first article, which appeared in our issue for July, treated of the general arrangement and equipment of the Epernay shops. The present part, concluding his description of these noted Continental works, deals chiefly with their mechanical practice and management methods and policy.—THE EDITORS.

THE erection of an engine at Epernay is generally effected over the side tracks upon the heavy wooden trestles which are noticeable in some of the views. Before the engine leaves the shop to be fired up outside for the hot tests, the weights under each of the tires are ascertained by means of an Erhardt weigher located at one extremity of the building. The shoe of this apparatus rests on the lower flange of the rail and by working the lever the wheel tire is raised one or two millimeters off the rail-head. For the regulation of the slide-valves, after the erection of the valve gear and before the side rods have been fitted to the wheels, it is necessary to be able to turn the wheels without moving the engine from its place. This is done by the aid of a very simple arrangement consisting of a spindle carried in special bearings resting one on each of the rail stringers and the spindles projecting through the bearings close up to the rail. Parallel with the spindle and carried by the same support is a stump spindle or loose roller, and it suffices to raise the wheel slightly in order that the flange of the wheel may drop in between these two spindles. A ratchet provided at the middle of the shaft is operated by a workman in the track pit, and thus the wheels are turned round slowly for making the necessary valve adjustments. A couple of these appliances may be remarked in the foreground of the upper view on the opposite page.

One of the numerous handy devices (of which so many are to be seen in use at Epernay for registering with precision the movement of any working part of a locomotive or for laying out erection work) consists of an attachment for the valve-chest ends by which the adjustment of the valves can be arranged with the greatest of facility, even with old types of engines wherein formerly, as in England at present, the slide valves were placed vertically between two



A LOCOMOTIVE UNDER ERECTION AT THE EPERNAY SHOPS.

Showing a small portable jib stepped into the steam-dome cover, with differential blocks for lifting heavy parts of the motion, etc.

inside cylinders. It comprises a bracket fixed to the front of the valve chest, close up against the "tail end" or extension of the valve spindle, and upon it are two adjustable cursors, the outer edges of which are set to represent the outer edges of the two steam ports. Upon the end of the valve-spindle extension itself another plate is fixed, and upon it are two regulatable plates or cursors whose outside edges are set to represent the extremities of the slide-valve; and when the wheels are turned by the ratchet apparatus just mentioned, the relative positions assumed by the valve on its valve-seating are exactly recorded outside. The steam port and the exhaust port dimensions are not visible from the apparatus, but for the verification of the valve setting this is not necessary. These instruments serve for several different types of locomotives.

For the lifting up of heavy pieces belonging to the motion or to the carriage of the engine, differential pulleys are used, suspended from a jib, the bearing for which is stepped into a hole in the steam-dome cover of the particular locomotive undergoing repairs or erection. This idea is shown best in the view just above.

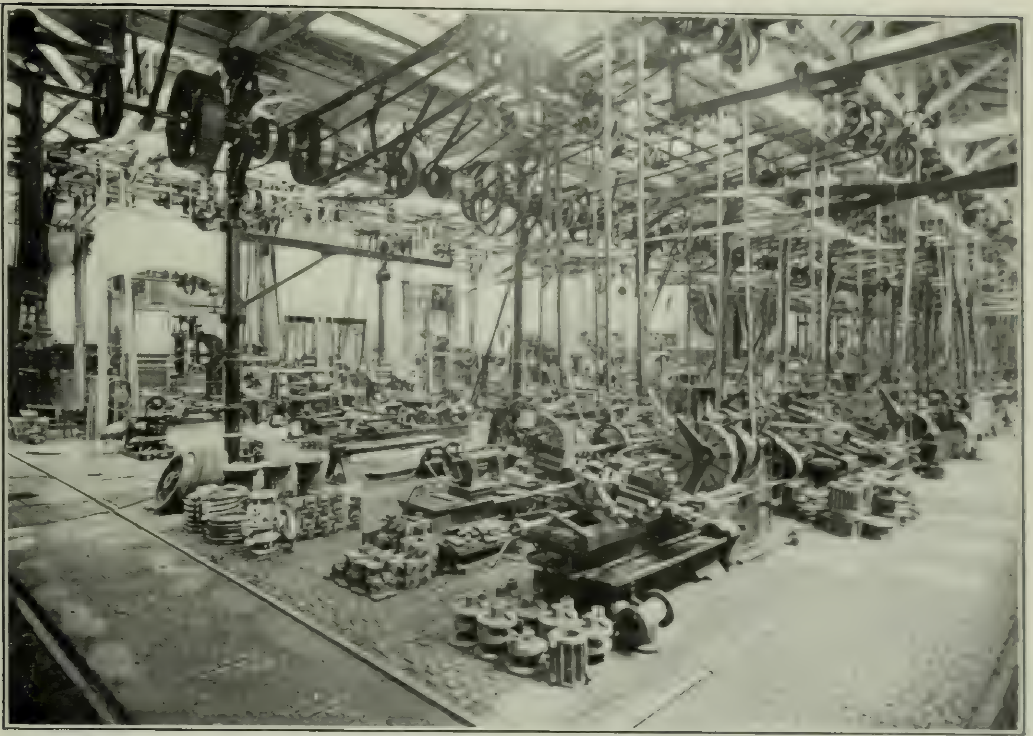
The parallelism and the geometrical squareness of all the members which form locomotive frames are tested by several different systems of gauges. It has been said that a locomotive-engine frame ought to be machined so exactly that it would tumble together without rectifications as easily as does a machine-made door. This is approximately possible where, despite certain objections, the frame plates have been planed inside and where long cast-steel frames or stretchers are used for bracing the plates. On the Continent, planing the inside of a plate frame is not approved of, it being considered that the skin of the plate is thus unequally cut through and so is liable to cause subsequent buckling. At Epernay, as well as in most European shops, recourse is always had to very exact tests for the rectitude of all the parts built into a locomotive frame. When the frame has been squared with tight-wire lines, the cylinders are temporarily bolted in place and the same means is used to verify their alignment, with respect to the driving-axle centers, and to the axial line of the cylinders, as also in relation to all the horn blocks or pedestals. Commencing with the alignment of these blocks, the Epernay shops employ a large gauging square which is bolted to the frames, between the horn blocks, by means of brackets and two of the horn-block bolts. Upon the cylindrical body forming the base of this instrument, and midway between the frames, is a long arm or compass beam with a needle point which must, in turning, fall exactly on the tight-line representing the cylinder's axis—first at its forward end and then, when turned around on the pivot, at its backward end. Further, upon the same brackets bolted to the engine frame, is fixed a heavy beveled-edge steel rule of which the feather-edge will represent the theoretical center for the axle when the horn-blocks have been duly verified as to being square, horizontally, with the axis of the cylinders, and also perpendicular to a line passing through the same axis in a vertical plane—all of which positions can by this instrument be ascertained with rigorous exactitude. The parallelism of the cross-head guides in respect to each other and in respect to the longitudinal axis of the pistons is tested by means of a gauge fitting in the inside of the guides and having a rack-and-pinion movement at its mid-length, adjustable laterally against the side of the piston. This appliance is of the simplest kind but it permits the gauging to be done rapidly and with all-sufficient accuracy.

For adjusting all the horn guides in a same plane parallel to the cylinder's vertical axis, a tight line, run through the middle of the cylinder, again serves as the basis for the measurements, and a square, provided with a fine-pitched worm screw and cursor, is successively set up against the inside edge of each of the horn-blocks; the fine adjustments thus made being absolutely exact. All the horn-blocks, of course, previous to these measurements, will have been set exactly plumb by means of a plumb square. Work of this kind is necessarily expensive, but it is more than repaid in the production of engines that run with a minimum of internal fatigue and continue to run when a cheaply-built engine would have already disappeared from service.

Plate-Frame Construction.—In the frame department there are the usual large triple-head boring machines and a very fine double-head frame-slotting machine by the Sächsische Maschinenfabrik of Chemnitz—which is the standard tool employed for this work in nearly all Continental locomotive shops.

The riveting of the frames is generally done by hand and with cold rivets, it being considered that a cold-driven rivet fills the middle-length of the rivet-hole much more thoroughly and with a greater density of the middle fibers than a hot rivet, with which the exterior portions of the rivet hole are more readily closed up, before the inside stem has had time to be equally compressed throughout its length. Cold riveting is considered to be the best work where there are several thicknesses of plates to rivet up and where shearing efforts have to be resisted. For the frame caissons or "stretchers," however, the rivets are closed by machines. At that part of the frame to which the horn-blocks are attached it is usual at Epernay to rivet a heavy reinforcement plate of horse-shoe form over the outside surface of the frame. The horn guides at these works are usually cast in two pieces instead of one piece as is now more usual elsewhere.

General Machine Shops.—The machine shops have an excellent tool equipment with machines from nearly all tool makers on the Continent of Europe and also from England and America, although, of the two latter, the former predominate, especially in the automatic department where for bolt and screw making the sets are mostly from Herbert of Coventry, and also from Pratt & Whitney of Hartford. Among the newest automatic machines is a Herbert lathe for copper screwed stays and another for screws and bolts; a lathe for crown-stay bolts by Jones & Lamson; a milling machine for working long surfaces by Loewe & Reinecker, and the well-known radial arm machine of Kendal & Gent for drilling and tapping cylinders. There is also a multiple-spindle drill for cylinder work, boring eight holes simultaneously on the system of Habersang & Zinzen of Dusseldorf.



FITTERS' MACHINE SHOP.
Showing installation of Gisholt lathes.

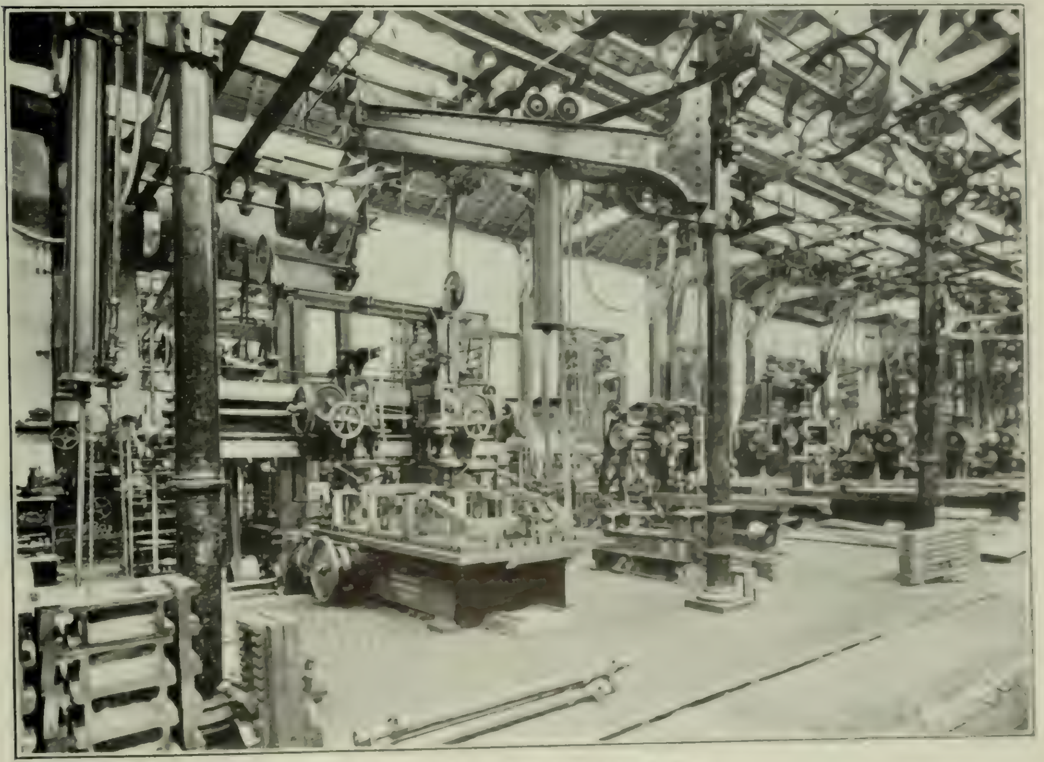
In the fitting shops there is a set of three Gisholt lathes which are to be seen in the foreground of the view above. These machines are employed principally for such repetition work as pistons, piston rings, stuffing boxes and packings, brake pumps, brake cylinders, and valve-chest liners, also for the piston-valves. Some of the work done by these machines may be observed in the same view. The European shops are few where these celebrated machines are not highly appreciated.

Capstan or turret lathes ("revolvers") are largely employed at the Est works for small parts, and these are shown in the background of the view on page *662* behind a row of milling machines. Milling machines are employed instead of planing machines wherever possible, and sometimes also for smaller parts where their use involves complicated forms of cutters, such as for milling reversing-gear handles, and the jigs for such pieces are frequently contrived so that the whole piece may be finished throughout without moving it on the milling machine. The I-section main rods and side rods are machined entirely from end to end by milling machines, and as much as possible at one pass. A cutter of large diameter is preferred, one having many more teeth than in the smaller sizes, and which, while holding out for use longer, yields smoother surfaces with a less loss of time unavoidable for sharpening. The solid cast-steel cutters have a diameter of 10 inches by a length of 16 inches and weigh 400 pounds. As occasional accidents in hardening are inevitable after repairs, the Est has for some years past employed cutters with changeable cast-steel teeth set in a core of mild steel. These teeth are helical stampings, and each blade is in two pieces with a splice at the joints. A cutter of 10-inches diameter and 12-inches long weighs 375 pounds.

GENERAL MACHINE SHOP. CAPSTAN-LATHES AND MILLING TOOLS.

These milling cutters can remove from a surface of medium-hard steel, when working at a circumferential speed of 40 feet with a feed of 5/8 inch per minute, a weight of 15½ pounds in 10 minutes, equal therefore to 93 pounds per hour, the cut being 15½ inches wide by 3/8 inch deep. Besides serving for the heavy motion rods they are employed for machining the insides of locomotives axle-boxes when these latter are set in gangs, as is practised also for machining the surfaces of cross-head guide bars. It should be observed that the side rods of Continental locomotives have very broad ends to be machined. A simple bushed eye, as in American and English engines, does not meet the need for taking up play.

For milling over every side of the foundation rings of fire-boxes a heavy English machine with double milling spindles is employed. This is an especially fine machine by Muir of Manchester, and its details may be noted in the view opposite, where it stands in the foreground. It is served (as too are the adjacent machines) by pillar cranes of 1½-tons lifting capacity worked by compressed-air cylinders, to be noted in the same photograph. In this interesting part of the works may be seen a Langbein milling-machine for sawing off the rough edges of all pressed-steel or flanged work, or the lower edges of assembled fire-boxes. This machine is much used throughout the Continent for milling the edges of all boiler plates that have been bent at right angles, or for dressing the edges of an assembled boiler ring. Its milling cutters are practically fine saws, and the tool provides all hinged motions for following around automatically the contours, regular or irregular, of any pieces upon which it is set to work. The two rollers which support the opposite sides of the piece being worked have sufficient space between their inside edges to allow the passage between them of the milling cutter when it has cut right through the plate. For grinding out, after hardening, the — grooves of the box-type valve-motion links so much in vogue on



MILLING-MACHINE DEPARTMENT.

Est locomotives, there is a very beautiful grinding machine designed and constructed at Epernay and kept in a room by itself. It consists of a strong vertical grinding head and a box table about 2 metres long. Its principal feature is the means by which the small traveling platform carrying the link can be made to describe an arc of longer or shorter radius to suit different radii of links. For this purpose the grooved slide-bed is hinged at the middle and its ends are adjustable by screw to a very fine scale marked upon the extremity of the bed. Depending upon the obliquity given to the jointed bed, and the obtuse angle which is so formed, the carriage holding the link turns through a curve of proportionate radius.

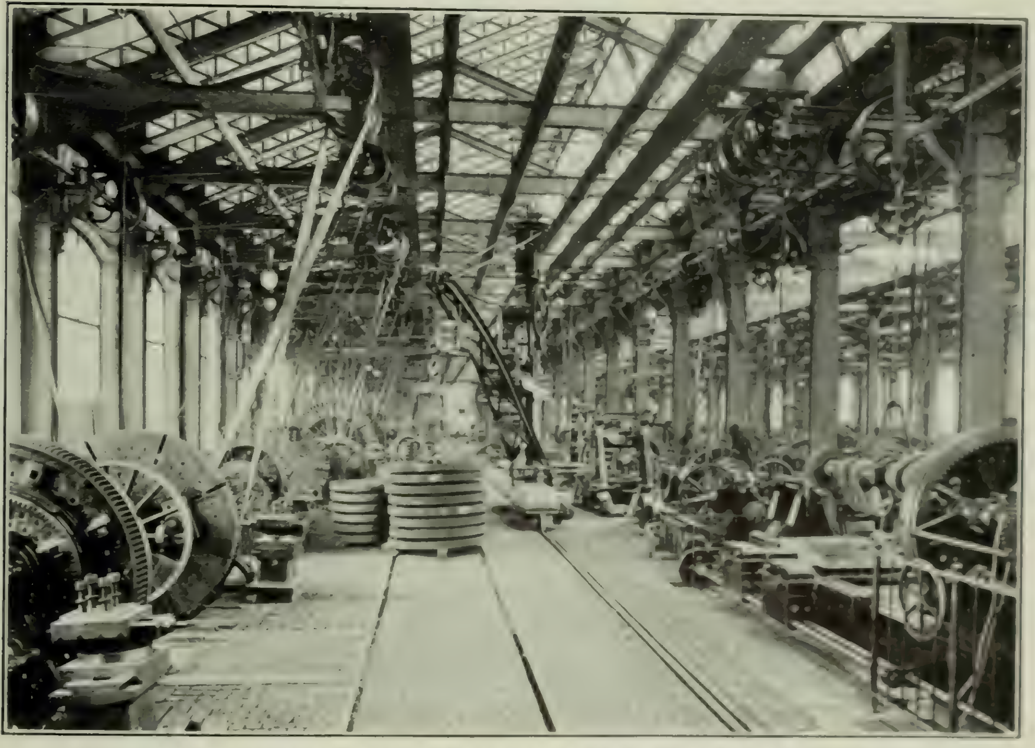
Wheel Shops.—The whole shop is a fine modern building and one of its bays is shown on the opposite page. Here the materials are handled by an electric monorail 4-ton floor crane of the Dyckhoff system with a motor of 4.6 kilowatts for lifting and another of 3.2 kilowatts for traveling, both by the Société Alsacienne de Constructions Mécaniques. For local service there are several half-ton radial-arm wall cranes. In the view given the floor crane is about to lift some driving-wheel centers for mounting upon the various lathes. Until recently the wheel centers were forged and were supplied from such firms as the Compagnie des Forges et Aciéries de la Marine et d'Homécourt at St. Chamond; from Deflassieux Frères at Rive-de-Gier, and from the Société Anonyme des Etablissements Arbel, also at Rive-de-Gier; but now, with the excellent results given by steel castings (a wheel center never having been known to break in a service of seven years) steel-castings centers are used and are supplied from Schneider & Co., Le Creusot; from the Compagnie des Forges de Châtillon, of Commentry et Neuves-Maisons, and also from the St. Chamond company previously named.

The lathes used are principally of well-known European types; but there is also a new wheel lathe by the Pond Co. and a vertical lathe or mill by Bullard of Bridgeport for diameters of up to 5 feet 3 inches. It may be mentioned, incidentally, that throughout the Continent few locomotive builders ever employ these latter machines for large work, or to anything like the extent customary with stationary-engine builders.

The method of securing the tires to the wheel center is, as now usual on the Continent, by safety rings—these rings being bent up in a small hand worked machine by Henschel & Sohn of Cassel (Germany). There is an extensive outside annex for the wheel shop termed a "wheel park" where all the new wheels and axles mounted are laid out according to the types of locomotive for which they are intended.

Axles, straight and cranked, are also machined in the same wheel shop. The forgings for the crank axles are of course obtained outside, the firms supplying them being the "Fonderies, Forges et Aciéries de St. Etienne"; Schneider et Cie of Creusot; A. Lacombe et Fils of Rive-de-Gier and the Forges et Aciéries de la Marine et d'Homecourt at St. Chamond.

Out of all the "Est" four-cylinder compound locomotives there are 83 which have the modern-type oblique-shaft crank-axle ("bras-oblique") that is now so much used on the Continent of Europe from its being much stronger in its form than the old right-angle crank type, still employed in England, but rapidly becoming obsolete on the Continent. Taking the whole of the inside-cylinder engines of the Est, both old and new, 40 crank axles of all kinds are renewed each year, the fractures when they occur generally starting in the crank pins.



TURNING SHOP FOR WHEELS AND AXLES.

A crank axle for the 6-10 type four-cylinder compound weighs when completely finished 2,035 pounds, and costs for material and work about 14½ cents a pound. The form of crank cheek or web now preferred at Epernay is not of the circular but of the elliptical pattern, although the circular pattern has an advantage over this last for the more easy fitting of the reinforcement hoops. Such a one, but with a straight-arm axle, is shown on the right-hand lathe in the view above. Here there may be noticed an arrangement (rarely employed elsewhere) for supporting the middle of the axle while on the lathe. Attached to the middle of the axle is a collar which is hung from a pulley on a roof beam by means of a broad strap, which latter passes over it to a second pulley and then down to the rear of the lathe, where there is a well in the floor for a heavy counterweight attached to a long rod in connection with the strap. Thus the axle has no weight on the lathe centers and consequently can be manœuvred with especial facility on the machine.

Boiler Shop.—This shop is served with an electric traverser mounted with a Gramme motor of 3.3 kilowatts (4.4 horse power). The furnaces, plate rolls, edge planers, drills, riveters, and other large heavy tools are only a repetition of all such plant usually seen in Continental works. The water used in the Est locomotive boilers is of a variable purity; on the whole it is calcareous. When taken in at Paris the water is notoriously hard, and at Epernay also it is calcareous and an old leak in a boiler under repair shows up this fact; but at Belfort, near the end of the Est lines, the water is remarkably soft. It is interesting therefore to know the nature of the repairs required by the steam generators. Out of one hundred boilers entering for repairs, seventy will be for renewals of the fire-box (always of copper), ten only for the tube plates, and twenty for various small boiler jobs. At present all the tubes are in mild steel, brass tubes having now been completely discarded just when elsewhere (i. e. in Italy) the steel tubes are to be entirely replaced by brass ones. The "Est" steel tubes have not the copper ends common in Continental practice—and even when they are repaired the piece soldered on is also of mild steel.

The copper stays for the fire-boxes are bored, at the inside ends only, with a hole 6 millimeters diameter to reach just as far as the water space. They are manufactured complete—viz., turned, screwed, and cut off to the required lengths—in a Herbert (Coventry) automatic machine, the quantity produced per hour averaging forty.

The stay-holes are tapped and screwed home by means of a 2.3-kilowatt Belfort motor already described. All the boiler riveting, caulking, and tube-beading is done by compressed-air tools—Boyer's being in general use. The air-compressing plant in the power house is also American—the compressor being by the Rand Drill Co. of New York—a two-cylinder compound machine with water circulation having a capacity of 7,000 litres per minute forcing the air into two reservoirs of 142 cubic feet capacity at a pressure of 94 pounds per square inch, and ceasing work when full pressure is attained.

The boilers and cylinders are not jacketed with any non-conductive material, but are merely covered with an airtight sheathing according to the general Continental practice.

The chimneys of the "Est" locomotives are usually made from wrought iron for the sake of lightness. Across the top of the blast pipe there is a strip of metal with an inverted cone riveted below it, its purpose being to spread the steam issuing from the pipe and to make the jet fill the chimney more completely—although it may be noted here some very much more elaborate arrangements, spreading the jet very effectively, have elsewhere been found to produce no appreciable advantage upon the draught.

Foundry.—The foundry, which is located at the end of the works nearest the railroad line and next to the forge-shops, employs one hundred men in the iron and brass departments. The iron foundry has two cupolas, one of 4,000-kilogrammes and the other of 1,800-kilogrammes capacity per hour, and casting is carried on daily.

The locomotive cylinders cast at Epernay appear to be of very good quality and the mixture employed is:—

English pig	30 per cent.
French hematite	30 " "
Old cylinder scrap	20 " "
Best chosen C. I. machine scrap	20 " "

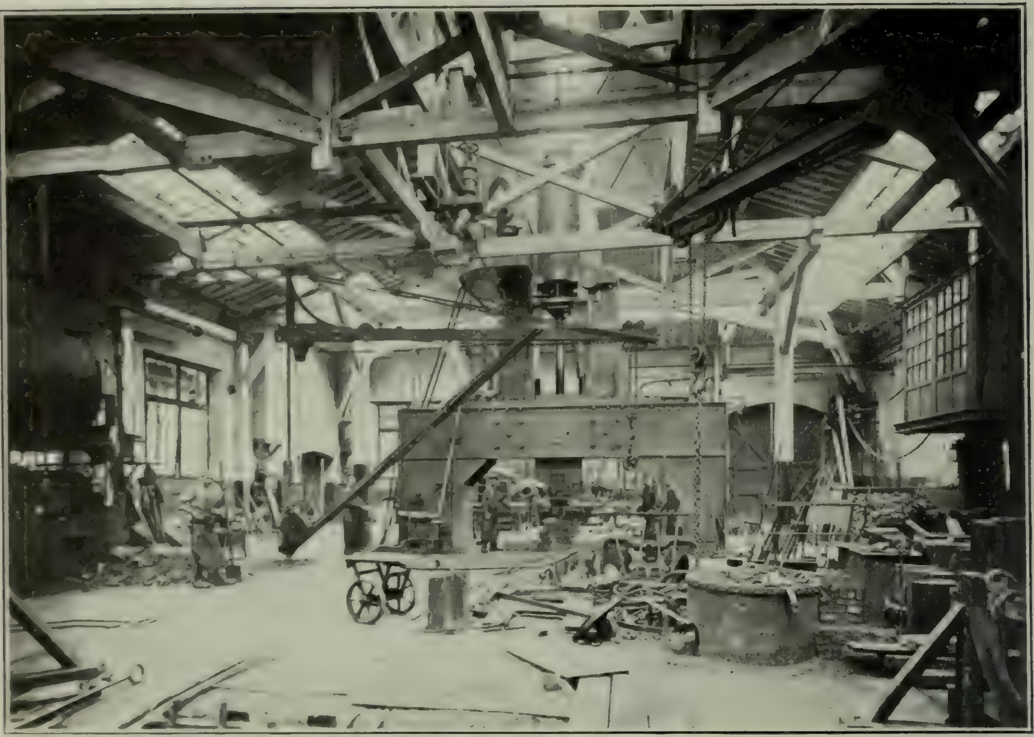
The following mixtures of sand, etc., are employed for moulds that have to be ovened:—

Green sand of Sainte Menchould	6
Mineral black (pulverised coal)	1
Old sand	8

A deep runner-head is usually employed for obtaining the required density of material in the cylinders.

The foundry "monkey" is located directly outside the cupolas so that there is practically no horizontal distance to traverse in carrying the prepared "scrap" to the furnaces.

Concentration, and Axle-Box Forging.—Between the foundry and the forges is a cementation department. Cementation and annealing are largely practiced. All the valve-gear parts are cemented, also the rod ends, brake parts, and forged axle boxes—though it may be remarked here that steel castings are now becoming very general at Epernay for axle boxes. When locomotive axle boxes are forged, their great depth causes difficulties in the employment of dies, so that at these shops the method usually followed is to first forge a straight piece having a swell in the middle for the crown of the box, then to swage the edges to the usual — section, and subsequently in a mould to draw down the middle or crown portion and complete the operation of forging the crown between dies. After this the long ends forming the sides of the box are bent down between two outside anvil blocks, and finally the piece is completed upon an internal model or saddle block.



A PART OF THE FORGE SHOP.

For the making of an axle box, weighing when fully machined 110 pounds, it suffices, with this process, to start with a block of 265 pounds. The rough forging weighs about 180 pounds.

Forge.—In the smithy the largest steam hammer (see view above) is by Thwaites Bros. of Bradford (Yorkshire), and was erected in 1902. It gives a blow of 12 tons. The steam cylinder has a diameter of 38 inches and has a maximum stroke of 7 feet. It is used principally for drawing ingots and forging locomotive rods and guide bars, as also for forging large work in dies. This forge shop is one of the busiest in a locomotive works that I have seen, and as it is very crowded with machines, accidents from sparks are alone prevented by the use of numerous iron screens set up on the floor between the various hammers.

The steam hammers are supplied with steam from two locomotive-type boilers mounted directly on the top of the forge furnaces. One of these boilers may be seen in the left hand of the view Figure 14. They have a heating surface of 176 square metres each (1,893 square feet) and are intended as a permanent installation. In the bolt-making section of the forge shops the machines are run by a Gramme motor of 9,350 watts.

Paint Shop.—The paint shop is a relatively important one for such a works as Epernay. It can accommodate twelve locomotives and tenders, whereas in most French, Austrian, and Italian locomotive works six is the usual capacity while at certain model works near Berlin four locomotives without tenders is the accommodation afforded and at Stettin (Pomerania) one locomotive without tender is got into the painting shop with difficulty.

Continental makers would like to be able to finish their engines with the hard durable painted surfaces which serve to give steam locomotives in England such an attractive appearance. On the contrary, Continental paints absorb the machine-oil and deteriorate rapidly so that the labor of keeping locomotives clean is an onerous one and especially so in France, where endeavours to keep up the fine painted appearance of a new locomotive are soon abandoned. But when quite new the engine painting is fully as creditable in appearance as the best English work, while the machinery itself of the Continental engine is certainly not inferior either in proportions or finish to work done elsewhere.

For the service of this shop there is a 38-foot 6-inch turntable provided with a 3,300-watt electro-capstan for turning the table and for hauling cold locomotives. The same motor serves to pull engines into or out of the painting shop. The paint-preparing shop has mixing and grinding mills and a grind stone for sharpening tools, all run by a Gramme motor of 3,300 watts.

The oil-stores, etc., are contained in an isolated building where the motive power consists of two Gramme electromotors each of 1 kilowatt, one for a 1-ton elevator and the other for a rotary-oil-pump. For extracting the oil from turnings and borings there is centrifugal machine by Reed & Curtis.

Materials Testing.—In the materials-testing department there is a tensile testing machine for metals worked by a Postel-Vinay motor of 4.6 kilowatts (6 horse power). For testing by concussion the samples cut from piston rods and valve spindles are placed under a falling weight or "monkey." For the last seven years the "Est" company subjects these parts to a system of double hardening which has had a remarkable effect in increasing the strength. The steel employed has, before treatment, a tenacity of 50 kilogrammes per square millimetre and an elongation of 25 per cent. After forging the rod is heated up to 950° and then plunged vertically into water that is steam-heated up to 70°, and left therein until it is quite cold. The rod is then reheated to 500° and again treated in the same manner. A rod scarcely ever breaks that has been treated in the way described. The test specimens are 20 millimeters thick and after being nicked with a triangular cut to a depth of 1 millimeter they are placed upon supports located 106 millimeters apart. The "monkey" has a weight of 50 kilogrammes (110 pounds) and is sufficient to break specimens cut from ordinary annealed pistons when falling from a height of 25 centimetres, while samples cut from the same piston, but double-annealed, do not break until the height of fall is increased to 2.30 metres and occasionally to as much as 3 metres.

General Installations.—The lighting, warming, ventilating, and hygienic installations in general of Epernay works are especially worthy of attention, if it is remembered that the conditions to be met were not entirely the same as with new shops—the laying out of which presents little difficulty with the specialised systems of heating and ventilating now available. For the lighting there are three Gramme six-polar dynamos driven by belting from the Corliss engine, their full-load efficiency being 86 per cent. and each delivering 36 horse power, or a total for the three dynamos, at a tention of 110 volts, of 108 horse power. Incandescent lamps are comparatively little used because of their fragility and small electrical output, but those already installed are kept up for night-watch service. The principal arc lamps are of Bardon type of 8 amperes. In the new erecting shop there are 44 such in the side aisles suspended at a height of 17 feet and 10 more in the middle passage at a height of 33 feet—which permits of the crane passing beneath them. The number of lighting hours is 400 per year. The switchboard permits of using the dynamos either for lighting or for power. The total production of electric power is 117,000 watts, representing 160 horse power. Of this 66,000 watts or 90 horse power is available for motive power, while the nominal strength of the machine motors in the shops is much more, being 174 horse power; but the power provided is largely sufficient since the normal capacity of the motors is much in excess of what they absorb on an average, and also because the small-tool motors are never all running simultaneously.

The central heating system consists of 1,200 metres of steam pipes connected with irradiator stoves. These were adopted because had floor heating been employed the pipes would have to have been laid in floor channels, and with the level attained by Marne floods this would have been impracticable. The channels also would have cost more for installations, and with the severity of the climate it was desirable that a workman should be able to warm himself up locally when the temperature had descended—as often happens in winter—

to — 15° C. and since it would not be possible to heat up the 80,000 cubic metres of space in the new shops to anything like a temperature of + 15° C. The cast-iron radiators are of Michel Perrets system, 20 in number in the erecting shop, with a heating surface of 23 square metres each, besides one of 6 square metres in the machine-tool department and one of 3½ square metres in the erecting foreman's office. Each one has a Hemtz system purge or drain cock. As the boiler pressure is 8 kilogrammes per square centimetre, a reducing-valve with relief-valve (Legat's) is provided for lowering the pressure of 3 kilogrammes per centimetre square. However, against the contingency that the reducer ever ceased to work, all the radiator pipes are tested by water up to 9 kilogrammes per centimetre square and safety-plugged for a limit pressure of 6 kilogrammes per centimetre square. With this heating system the temperatures recorded during trials and taken at a height of 6 feet 6 inches from the floor were as follows:—

Outside temperature.	Inside temperature.		Rise of temperature.
— 10° C.	+ 5° C.	=	+ 15° C.
— 5° C.	+ 7° C.	=	+ 12° C.
0° C.	+ 10° C.	=	+ 10° C.

Steam Transmission.—The steam is transmitted from the boilers to the various shops, both for motive power and for heating, by means of overhead pipes supported through the distances intervening between the shops by suspension cables hung in the manner usually adopted for bridging wide spaces. There is a total of 280-metres length of steam mains, and the most important consideration with regard to the installation of this was the employment of an efficient non-conductor of temperature. No silk is used for this purpose, the principal non-conductor being the thickness of 3 centimetres of a mixture composed of goat's hair 1.5 per cent., best quality refractory earth 40 per cent., refractory sand 25 per cent., moistened with water, for mixing, up to 53.5 per cent. Around this layer is bound soft cord soaked in yellow earth followed by more coils of soft cord or of straw bands soaked in brick-earth mortar containing 10 per cent. of horse droppings, the winding of the coil being tightened up towards the outer layers. This is all thickly covered up with mortar and then incased in three-ply pitch-paper followed by a layer of tar over which is wound from one to three coils of osier rope. Where the pipes pass outside the buildings there is a protective covering formed of a number of layers of thin canvas, followed by several thick coats of linseed oil (1 part) mixed with black lead (half-part).

Hygiene.—In all Continental locomotive shops the hygienic precautions taken where a great number of work people are massed together are on the whole generally good, although not all of these are so elaborately contrived as are those of, say, the State Privileged Locomotive Works near the Sudbahn Station in Wien. At Epernay the lavabos are provided in the erecting shop itself, and consist of long troughs which drop down, when required, from their vertical position against a roof column and then provide place for 8 to 10 men at each one. The floor beneath is of brick, which is soft enough not to injure a piece of work that may by accident fall.

For the supply of pure drinking water the river Marne was to be avoided as a source, so tube wells were driven to a depth of 50 feet into the middle of the chalk stratum and 30 feet above the alluvial beds, so that any injurious infiltrations were not possible and micro-biological analysis proves the water-supply to be excellent. This water is pumped into reservoirs, and concentric cisterns or drinking fountains are conveniently located in the shops, the outer envelope serving to keep the inner one cool—although it has yet to be learnt that warm water is a better thirst-quencher and less injurious to the system and besides a saving of the workman's time. In summer-time extract of coffee is put into the inner vessel, and this tempers the chilled water much as would the English workman's oatmeal drink.

A telephone connects all the workshops and the whole of the works is equipped with fire-alarm bells which, in emergency, would sound all together with the works "tooter." There are also motor alarms working between the engine room and the shop motors.

Educational.—At Epernay there is an admirably-organised school for apprentices and the courses of instruction given, as shown by the programme which includes elementary mathematics, are really excellent in every respect. The "class-room," however, has not the imposing appearance of some similar institutions on the Continent, as for example the apprentices' class-room of the Hungarian State Railway Works at Budapest and at Diosgyor. In the shops these lads whose minimum age is 13 years have a working department to themselves—a "nursery"—where they are in the care of proficient mechanical instructors. Instructive examples of vice-work are hung up on the walls of their shop, and adjoining this ward there is a lavatory where the apprentices can also learn habits of cleanliness both in going from and coming to their work.

In concluding these notes I desire to acknowledge my indebtedness, while visiting the works, to the courtesy of M. Desjeans, the chief engineer, and of his assistant-engineer, M. Fort.

ENGINEERING EXPORTS OF BRITAIN, GERMANY, AND THE UNITED STATES.

By W. Pollard Digby.

This article concludes Mr. Digby's analytical study of export-trade statistics. It began in our issue for June last, and took up first the trend of supremacy, as disclosed in the general situation, and next the relative importance of the three great manufacturing nations in each of the most valuable markets for export trade. The graphic method of presenting results adopted by the author makes his conclusions and deductions particularly easy to grasp.—The Editors.

IN preceding articles we have reviewed the general situation as it affects export trade in engineering manufactures, and have traced the trend of advance or retrogression of the three great manufacturing nations in the most important trade zones. It remains, before a general summing up, to consider the conditions in certain remaining regions which are specially related to Great Britain by colonial ties.

West Indies and Adjacent Countries.—Passing northward from the great South American continent, we come to the somewhat scattered group of countries which comprises the West India Islands, Mexico and the various Central American republics. The bulk of the trade is overwhelmingly American, as is shown by the following figures:

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United States	2,520	4,096	3,992	3,009	3,422
United Kingdom	1,114	1,179	1,013	1,331	1,092
Germany	335	455	512	827	735

Mexico, Cuba, and the British West Indies form the chief purchasing groups, the respective total exports to these three markets being shown in Diagram No. 1. Mexico makes the largest purchases from each country—proximity accounting for the largeness of the American trade. The Cuban trade is also in American hands, the British trade in engineering articles being quite small. The German trade to Cuba is even smaller, and cannot be represented on this diagram. The same remark applies to the German trade to the British West Indies, where British trade is in excess of that from the United States. The chief items of American exports to Mexico are shown under three headings in Diagram No. 2, from curves repre-

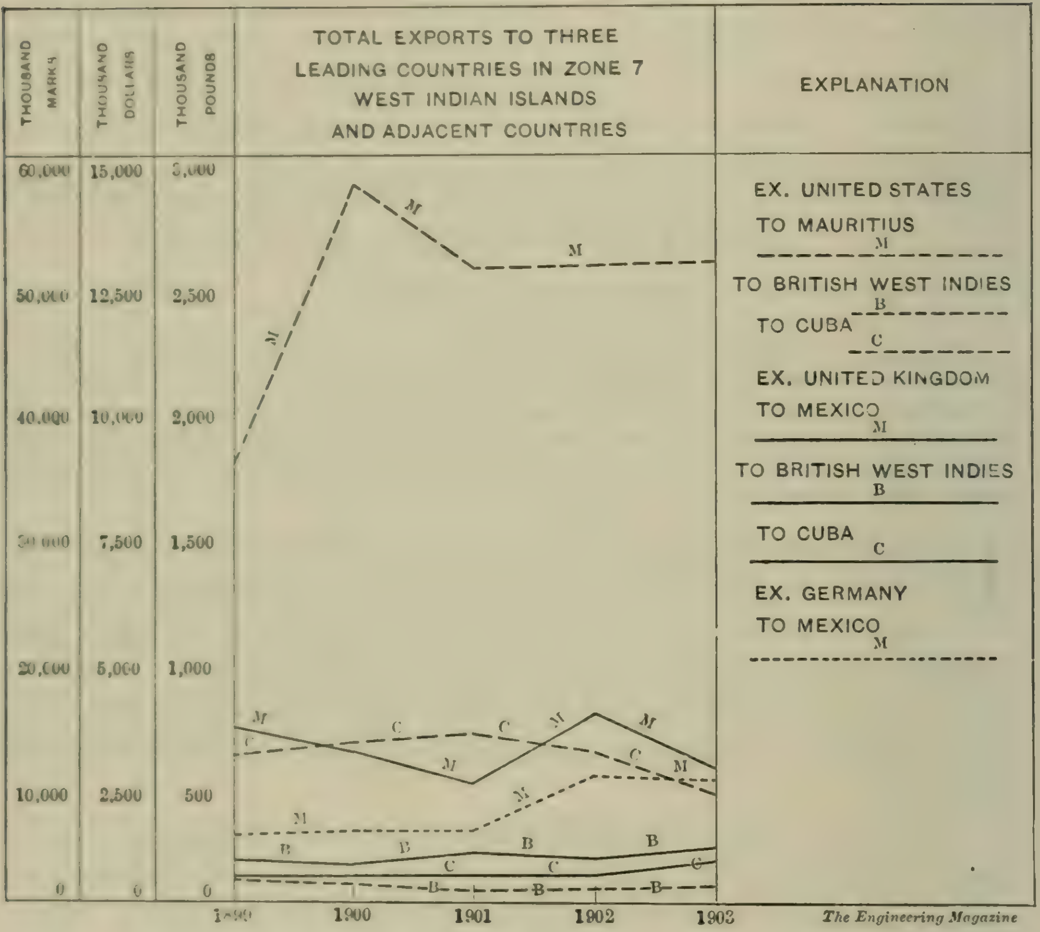


FIG. 1. TOTAL EXPORTS TO MEXICO, CUBA, AND BRITISH WEST INDIES.

senting the respective exports from the United Kingdom and Germany under two headings. The American machinery export is a very large one. Unfortunately the American returns of trade with Mexico do not classify it under sub-headings.

British North America.—The Dominion of Canada affords to the United States the chief market for engineering manufactures. Whereas goods from the United Kingdom can only enter at a few ports after a journey across the Atlantic, the railways which cross and recross the frontier can often bring material from American industrial centres at as cheap a rate as from the port at which a ship can discharge its cargo. The following are the figures of the total trade:—

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United States	3,028	4,384	4,664	4,657	5,035
United Kingdom	1,253	1,242	1,321	2,251	2,558

Second place is held by the United Kingdom, which has the slight advantage in the rebate of one-third of the customs duty paid on goods from other countries. Added to advantages of language, this is an important factor so far as competition between the United Kingdom and Continental countries is concerned. In competition with the United States this concession is of very little avail, as is evidenced by the foregoing figures, which show that while British trade has increased by £1,200,000, American trade has increased by £2,000,000. Diagram No. 3 shows the chief items of exports to Canada. As regards the increase of British and decline of American exports of iron and steel wares (other than machinery) generally, in 1902 and 1903, it must be remembered that these were years when exports from the

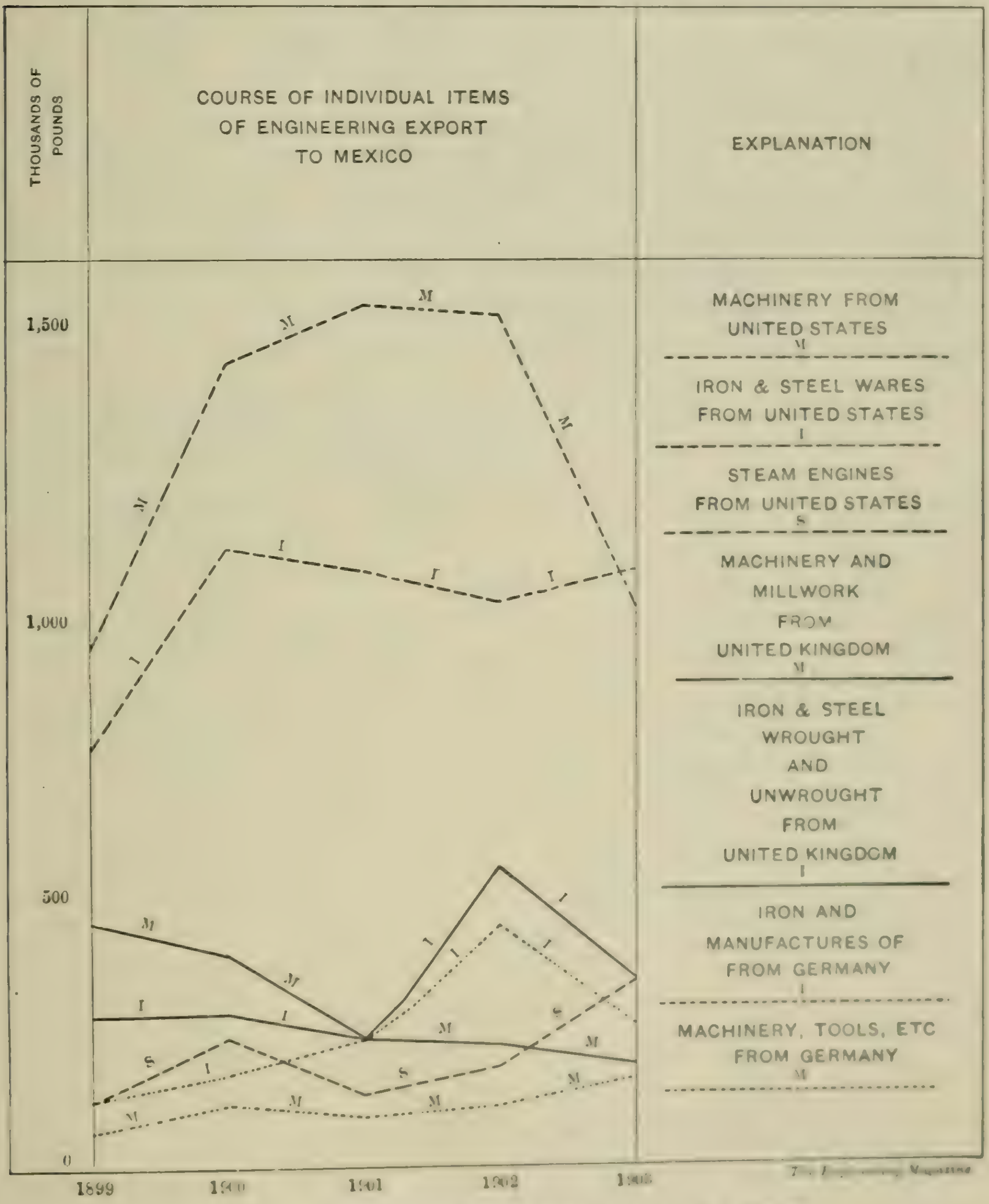


FIG. 2. FLUCTUATIONS IN EXPORT TRADE TO MEXICO.

United Kingdom to the United States were exceptionally heavy, owing to the great local demand.

British America.—The general rule—to which British North America is the one exception—that British exports to British colonies and dependencies are in excess of those of the United States or Germany, holds good with regard to British South Africa, and the scattered possessions on the East and West African coasts. The following figures give the total trade:—

Year.	1899.	1900.	1901.	1902.	1903.
Ex	In thousands of pounds sterling.				
United Kingdom	2,733	2,718	3,420	5,887	7,731
United States	794	390	513	639	885
Germany	360	248	342	610	907

The above table is one which would admirably lend itself to manipu-

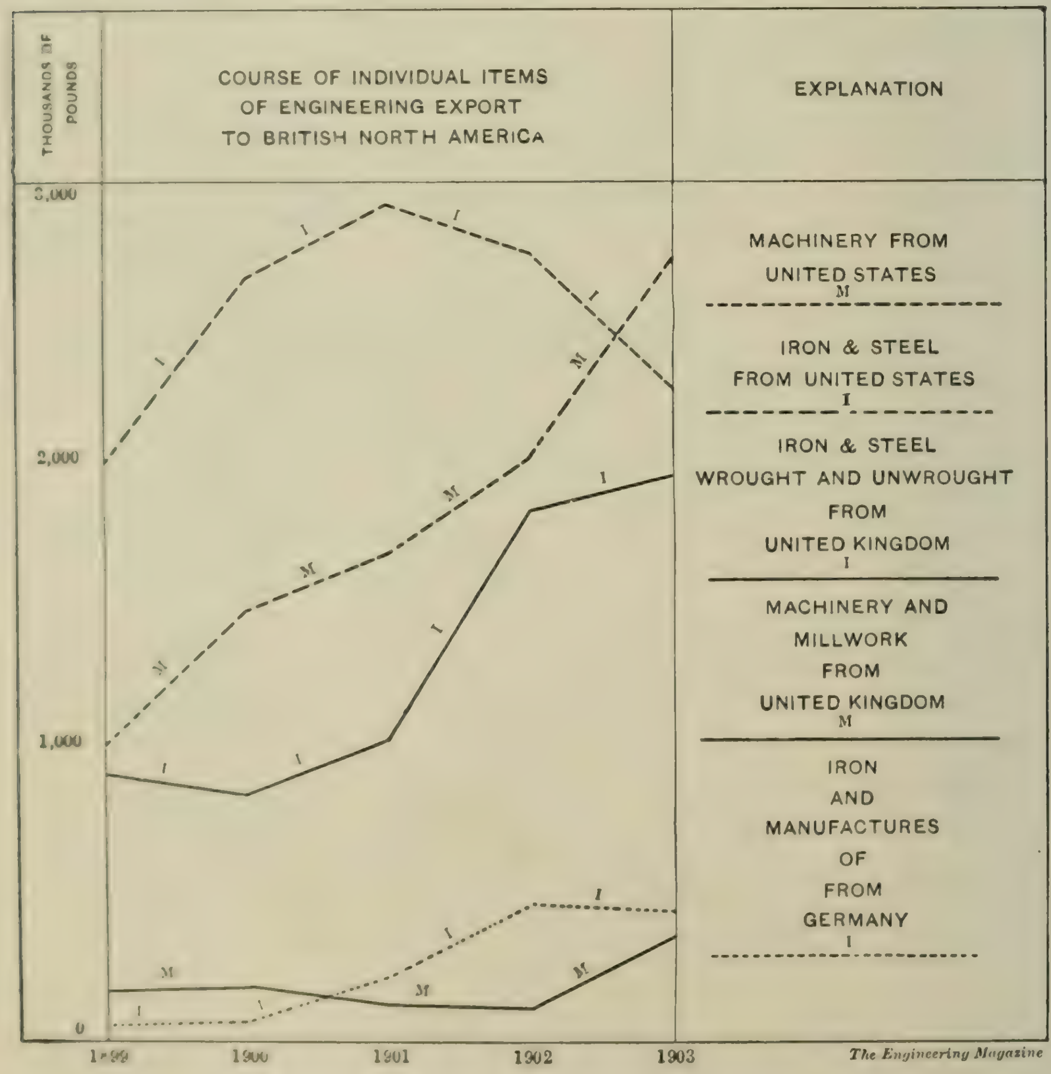


FIG. 3. COURSE OF PRINCIPAL ITEMS OF ENGINEERING EXPORT TO CANADA.

lation by a particular section of students of British statistics, who seek in statistical "facts" ammunition for a political campaign. It would certainly be a fact to state that if the exports of each country in 1899 had been taken as 100, the British figures would only show an increase of 134 per cent. to 234, while the German figures indicate an increase of 152 per cent. to 252. Yet in the one case the increase of 134 per cent. of the 1899 trade represents an increase of nearly £4,400,000, and in the other case the increase of 152 per cent. represents an increase of only £547,000. This digression into the realm of English politics is scarcely pertinent to the subject, but the practice in question of selecting an absolutely arbitrary date, and assigning an equal numerical value to widely differing sums of money or quantities of material, has been used in quarters of such importance that this digression may perhaps be pardoned.

In Diagram No. 4 are shown graphically, under certain comprehensive headings, the exports to British South Africa from the United Kingdom and Germany. These tell their own tale, and do not call for comment. No curves are given of American trade, partly on account

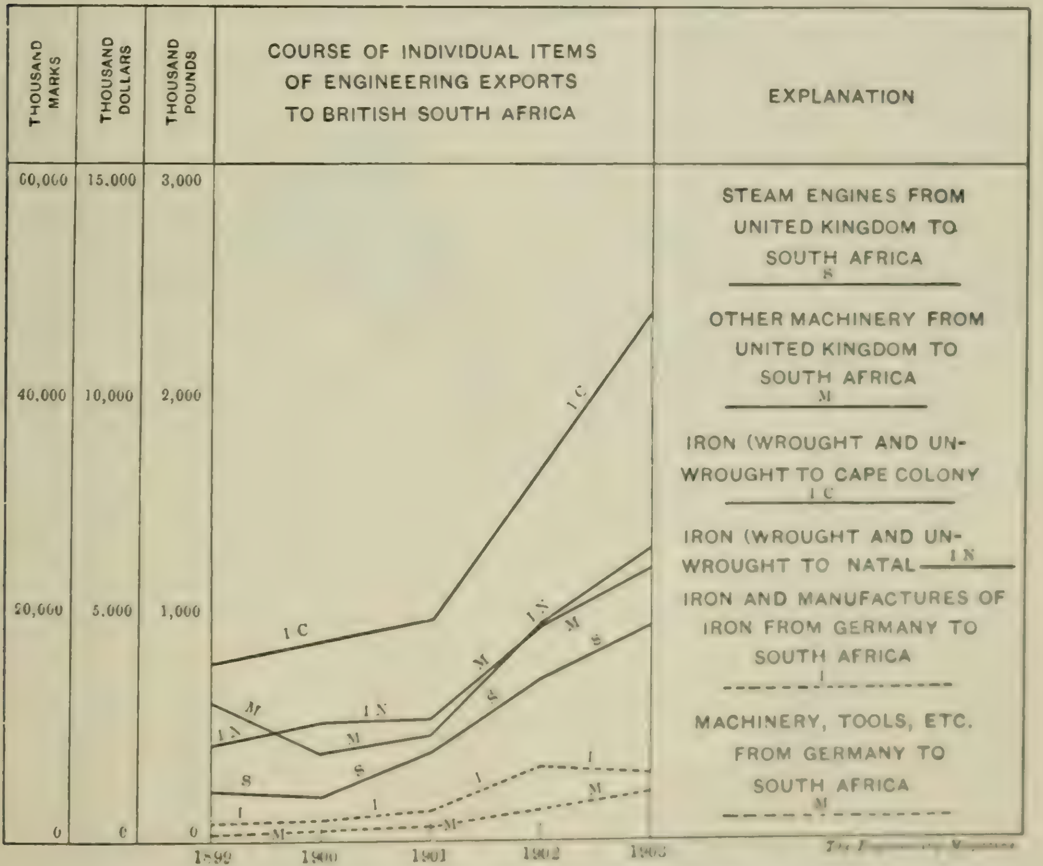


FIG. 4. THE TENDENCIES OF ENGINEERING EXPORT TRADE TO SOUTH AFRICA.

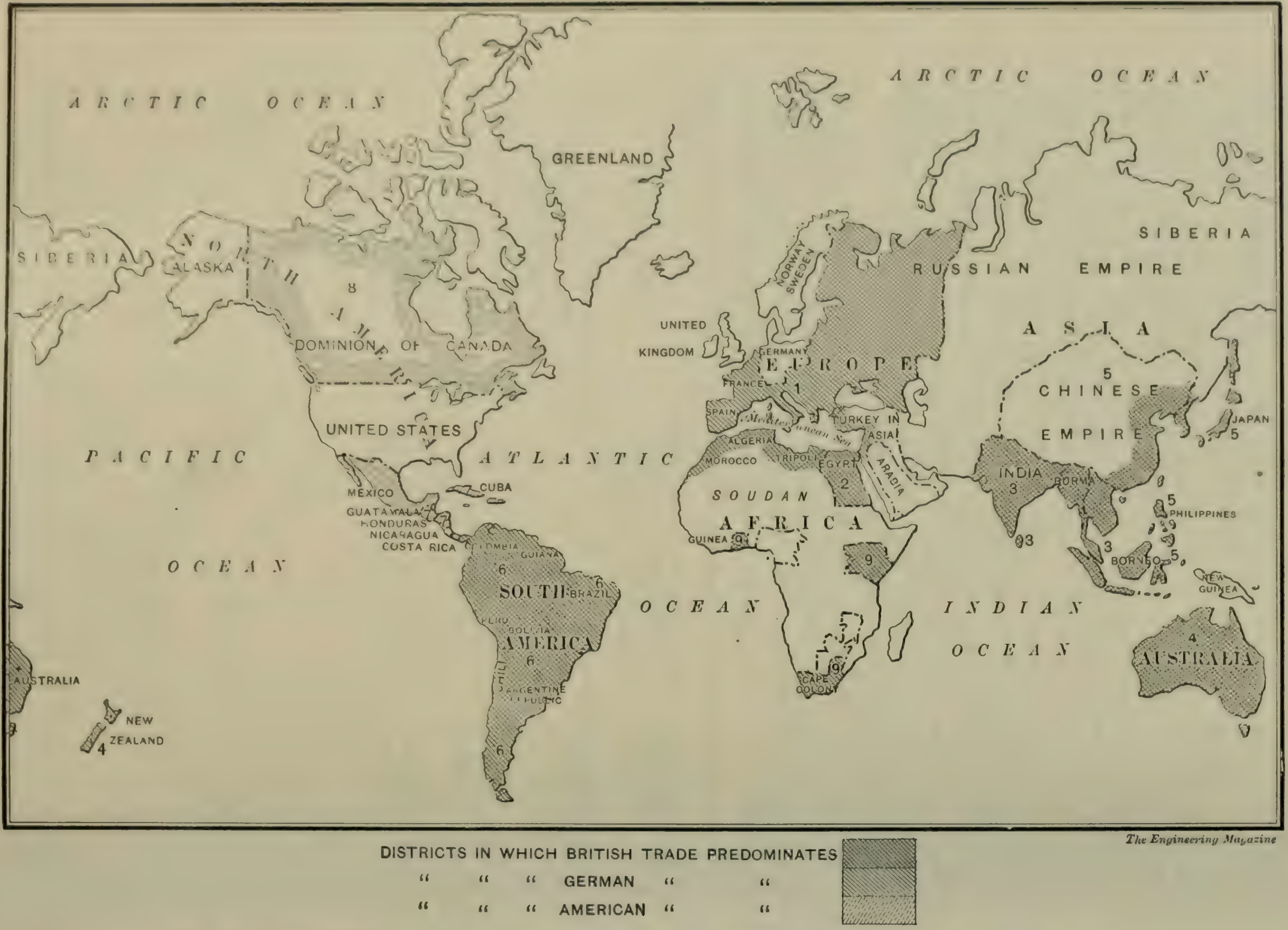


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FIG. 5. A GRAPHIC CHART OF BRITISH, GERMAN, AND AMERICAN DOMINANCE IN EXPORT TRADE. The trade-zone numbers correspond with those used by Mr. Digby in the body of his article.

of its relatively small volume, and partly because the American returns do not distinguish trade to South Africa from trade to the rest of the British possessions in Africa.

Reference to the map (Diagram 5) which appears on the opposite page, will shew at a glance the nationality of the country exporting the greatest quantity of engineering goods to each of the nine trade zones into which I have—perhaps empirically—divided the world. Each manufacturing country is, of course, supreme within its own borders. Passing beyond these, British engineering articles are first, in regard to (2) the southern and eastern Mediterranean seaboard, (3) the British East Indies, (4) British Australasia, (5) the Far East, (6) South America, and (9) South Africa. Germany is pre-eminent on (1) continent of Europe as a whole; and the United States is foremost in regard to (7) the West Indies and adjacent countries, and (8) British North America. In the three cases where Great Britain is not first, she takes second place—in each case by a very substantial margin. While this map—which would apply to any of the five years covered by this review—indicates the nationality of the manufacturers who are supreme in supplying each particular zone, too much emphasis must not be laid upon its indications. Thus, while the United Kingdom takes second place in regard to European trade, the margin between the volumes of British and American trade to the eight countries of this zone would more than suffice to cover the entire value of the American exports to British North America, plus half the value of the American exports to the British West Indies, the two zones to which American exports predominate. In order, therefore, to represent the volume of trade to the chief zones in the last year of the period under review, the final diagram (page 680) has been prepared, which conveys in the most easily recognizable form an idea of the importance of the exports to the chief zones in 1903.

It may perhaps be urged that the values taken throughout this review of engineering trade—export values at the port of the country of manufacture—should not have been taken, but instead the values at the port of discharge. To obtain these latter figures would have been a task of much difficulty, and the values registered would in each case have been swollen by costs of transport, the profits of which would go, perhaps, to the ship-owners of another country. Taking the prices at the port of shipment, therefore, represents more closely—but not absolutely—the importance to the manufacturer of the different markets. Also, in several cases, such as certain British colonies and certain South American countries, no distinction is made between goods of British manufacture and foreign-made goods re-exported. The official export values have therefore been taken. These do not in every case embrace absolutely identical goods, but any involuntary omissions of various items would not greatly swell the figures of any particular country. Every care has been taken to reduce these omissions to a minimum, but considering that these summaries have been prepared from items abstracted from trade returns embodied in something like seven thousand foolscap pages of statistics, some small omissions are almost certain to have occurred.

It is greatly to be regretted that commercial statistics generally are of so one-sided a character. On fluctuations of import and export statistics many hypotheses are advanced. In the case of a country absolutely without manufactures such figures are sufficiently satisfactory. But in the case of any large manufacturing country, such as those whose export trade has been considered to reduce prosperity or the reverse from figures of export or import trade, is a proceeding dangerous on account of its mere superficiality. Internal trade statistics are lacking in all but a few instances. As regards even these few instances, the majority are the results of figures collected by individuals or associations of manufacturers, and lack the hallmark of an impartial government authority. If the value of the output of the manufactured goods in certain well defined industries were computed with half the attention given to statistics of import and export trade, the fiscal problems of various countries would admit of an easier solution, and paths of doubtful economic sanity would no longer be pointed out by the blind leaders of a blind electorate as the road to national wealth and supremacy. The telescope *per se* is an excellent instrument, but to confine mankind to its use, or to keep a pair of binoculars glued to each pair of eyes, would not

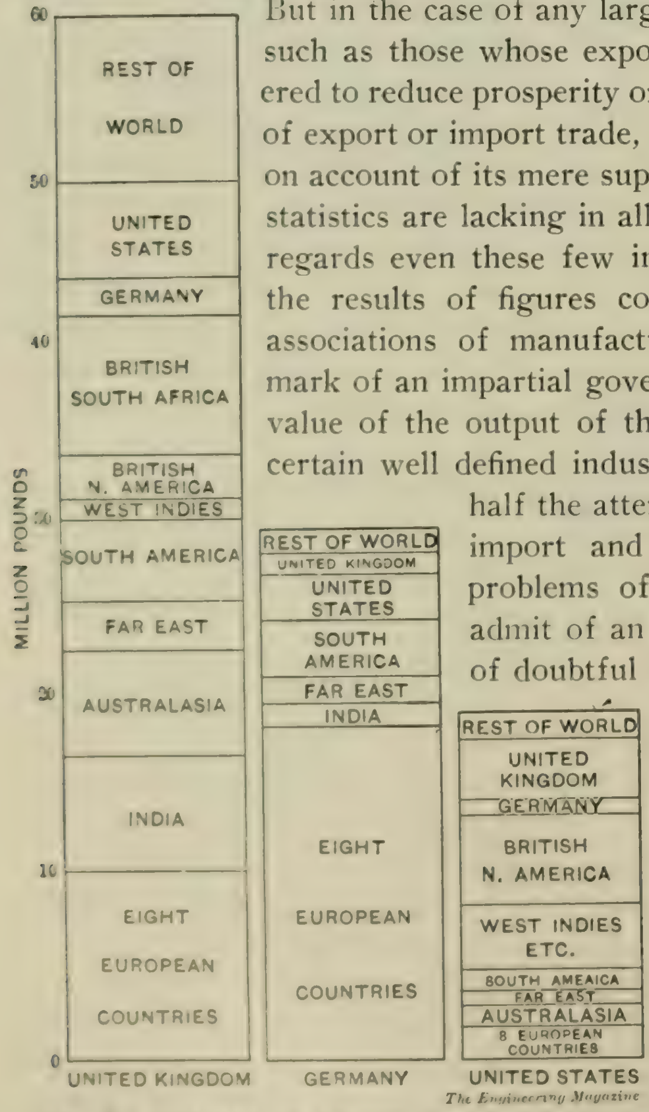

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FIG. 6. VOLUMES OF EXPORT TRADE IN 1903.

aid the race in its dealing with all the nearer, but by no means minor, happenings of life. Virtually, figures of imports and exports are a telescope vividly showing the minutiæ of over-sea trade. The community requires a statistical microscope, wherewithal the internal prosperity of a country may be examined in detail. It must be clearly understood that I do not despise figures of export or import trade. These require careful study as showing the manner in which any country not producing sufficient food stuffs for its population secures these, or in which capital in the shape of exports goes to an undeveloped country; or in which a capitalistic country receives the income on, or repayment of, a portion of its investments. If to a knowledge of the great trends of capital and industry, exemplified by import or export returns, is added the knowledge of the conditions of industrial trade, all the facts are at hand and the politician can enunciate axioms rather than theorems at present often incapable of proof.

Even if internal trade be ignored, the volume of external engineering commerce dealt with in this review is that of a complex but opulent nature. If the sense of civilization forbids internecine war between occidental nations, international competition still remains. In this industrial warfare brain power and intelligence will be—nay, must be—the dominating feature. It is recorded of that stalwart and genial soldier, Blücher, that his first impression of the London of his day was an overpowering sense of its tremendous wealth. "What a city to sack!" the descendant of the wild Teutonic tribes, who had extorted tribute from Imperial Rome, is said to have exclaimed. Today the very extent of British commerce gives rise to a similar feeling in the mind of manufacturers descended from Blücher's soldiers. The great contests will range around the neutral markets. To secure or increase a hold on these demands smooth working among many conflicting factors in each competing country. Some of these may be suggested, such as abundance of local supplies of raw material, or capital to exploit distant sources, together with a fiscal system admitting semi-raw or semi-manufactured material free of taxation. Of importance also is it that the artizan class should be sober, industrious, and intelligent. The manufacturer, who is the general of a division in the army of industry, needs to be equipped, not only with scientific knowledge, but with shrewd business instincts of organisation. In all countries certain of these properties are possessed to a very high degree; indeed in America and Germany intelligence departments are at work to aid the manufacture, but in several their reports are ignored. As an Englishman, I cannot but remember that one of the traditions of English history has been that in nearly every war opponents have been despised and contests have been entered upon in a state of utter unpreparedness. I take comfort in remembering that when once my country has felt a reverse, the tonic properties of that rebuff have helped it to do rather more than "muddle through." Challenged in several markets, displaced in some, the British manufacturer will set his works and machinery in order, and although modern conditions prevent his maintaining an absolute manufacturing monopoly, he will yet retain the lion's share of the world's engineering commerce, even in competition with German thoroughness and American energy, and despite American superiority as regards supplies of engineering raw material.

TEMPERATURES IN AIR AND AMMONIA COMPRESSOR CYLINDERS.

By Leicester Allen.

IT is somewhat remarkable, as we review the field of engineering activity, to find so many indeterminate factors the values of which must be assumed in our investigations and in our actual work. When dealing with such factors, individual judgment is compelled to take the place of experimental data, with more or less chance for errors in final results. One of these indeterminate factors is the mean temperature of the interior of an air-compressor cylinder, taking in air at a stated temperature and pressure and discharging the air at a stated presure. Does any one exist who could guarantee that from these data he can mathematically determine more than an approximation to the temperature of the air so discharged? Such an approximation may be all that is required for ordinary practice in building and operating compressors, but it does not meet the requirements for the scientific investigation of some of the problems of air and ammonia compression.

Take, for example, a case wherein a very high pressure is desired to be attained, space and cost also imposing the condition that the compression be accomplished in as few stages as possible, without producing excessive temperatures in the cylinders. In dealing with such a problem, we have of course the well established thermodynamic formulæ; but their use gives us theoretical results only, never attainable in practice. When we test by thermometers the temperature of compressed gases as they pass from the compressor cylinders, we find a wide discrepancy between the thermometrical readings and the theoretically calculated temperatures. We usually account for these discrepancies by attributing them to loss of heat by conduction through the walls of cylinders. We have never been able to find yet a perfectly non-conducting material of which to make, or with which to insulate, compressor cylinders, and so a notable fraction of the heat that would otherwise accumulate in the cylinder walls and the contained air escapes.

Now with very exact thermometrical work, we can quantitatively determine such escape by subtracting the heat contained in the discharged gas from that which it should theoretically contain as computed by the accepted thermodynamic formulæ; but having so found the transmitted heat, we still confront the question of the mean temperatures of the cylinder walls, cylinder heads with their valves, and the piston with that part of the piston rod which alternately works within and without the cylinder space.

These temperatures have a fundamental importance in the consideration of the subjects of cylinder condensation in reciprocating steam-engines, of superheating in ammonia compressors, and of such ratios of compression in air compressors as will be consistent with safety in their practical operation. One of the dangers in air compression which has not been fully recognized until within a quite recent period is the liability to explosion of air-compressor cylinders when the heat of compression is caused to exceed the flashing-point of the oil used for cylinder lubrication. Several more or less serious accidents of this nature have been recorded within a period of three or four years.

The interior temperatures of the metal of steam cylinders, pistons, and heads, have been experimentally determined for special cases, with a probable approximation to accuracy, but I know of no such experimental determination for air and ammonia-compressor cylinders. As related to the question of superheating in ammonia cylinders these interior temperatures are important.

In the introduction to the admirable translation of M. Ledoux' "Ice-Making Machines" by Professors J. E. Denton, D. S. Jacobus, and A. Riesenberger, page XXIX, Fifth Edition, Revised,—speaking of ammonia compression ice-machines, it is said:—

> "In compression machines employing volatile vapors, the principal cause of the loss of the theoretical result * * * * is the heating of the ammonia, by the warm cylinder walls, during its entrance into the compressor, thereby expanding it, so that, to compress a pound of ammonia, a greater number of revolutions must be made by the compressing pumps than corresponds to the density of the ammonia gas as it issues from the brine tank."

The statement quoted is based upon experiments actually made in a most careful manner by Professor Denton, the results of which are tabulated, on a folding sheet inserted between pages XVIII and XIX of the introduction. The volume of the condensed liquid ammonia, if there were neither loss by superheating between the brine-tank and the pumps, nor in the pumps themselves, should be exactly proportional to the volume of gas drawn into the pump at each stroke. In Professor Denton's experiments the volume of the liquid was found to be much less per stroke than it would have been had the same cylinder volume of gas been inducted at the temperature of the suction. As nothing is known that can lessen the weight of a given volume of gas except expansion, and as heat is the only possible known force by which, under the conditions, a gas can be expanded, and as the weight of the gas entering the pump must be exactly equal to the weight of the liquid resulting from the condensation, and this weight is a constant exact function of the liquid volume at any stated temperature, the inference drawn by these writers that the principal loss of theoretical result is due to superheating seems perfectly logical. Now, if the superheating be wholly caused by the contact of the gas with the previously heated cylinder walls, it follows that a system of compression which heats the cylinder less, will superheat the gas less, such superheating being a function of the difference of the temperatures respectively of the interior cylinder surfaces and of the gas. Such a system is the compound system of compression in two stages, with cooling after the first stage. The resulting temperature of a gas compressed adiabatically is a function of the ratio of compression. If the compresion be effected in two stages, with equal ratios of compression, each ratio will be the square root of the total ratio, and the application of the accepted thermodynamic formula for determining the final temperature of compression for any particular ratio of compression (the absolute temperature of the gas at the beginning of the compression being known) will show that the maximum final temperature will be much less in the two-stage, than in the single-stage system.

Ammonia, as it enters the compressor, in what is called dry compression, is either a saturated or a superheated vapor. Zeuner has supplied a formula for computation of temperatures of superheated vapors for any ratio of compression, and this is general for ammonia and for all condensible gases; and it is universally admitted that unless some liquid ammonia is passed into the compressor with the gas (wet compression), the gas at the beginning of the suction period will nearly always be slightly superheated. Assuming that in dry compression the gas is superheated slightly before it reaches the suction valves, in any case of dry compression the application of Zeuner's formula will theoretically determine the final temperature for any suction temperature and compression ratio. Air is, of course, in its normal condition, a mixture of superheated vapors.

Now it is plain that the interior of the cylinder can never reach a higher temperature than that of the gas at the end of the compression. The material warmed by contact can never become warmer than that which warms it. This is a fundamental law of heat transmission. It is also plain that a surface alternately exposed at equal and short intervals, first to a medium hotter, and second, to a medium colder than itself, must take, and substantially retain, some average temperature between the extremes. When the extremes are constant, it might plausibly be expected that the intermediate temperature would be the mean of the extremes.

The temperatures at different periods of the operation in Professor Denton's experiments are tabulated on page XXXIV of the introduction to the work already cited. In the suction pipe, just prior to entering the cylinder, the absolute temperature of the gas was 485 degrees F.; at the end of the suction it was computed to be probably 617.6 degrees F., the gas having been superheated 132.6 degrees; at the end of the compression it was 995 degrees F. The extremes of temperatures to which the interior surfaces of the cylinder were subjected are therefore 995 degrees and 485 degrees absolute, the mean of which is 740 degrees absolute. Assuming this to be the substantially average maximum temperature attained by the metal surfaces, we can reason as follows:—

Since the metal can give off to the cooler inflowing gas during one revolution of the compressor crank no more heat than it receives during one revolution, while working uniformly, and while the gas gets warmer the metal gets cooler, the greatest possible superheating would be at the instant whereat the metal surfaces and the gas, the former by cooling and the latter by heating, mutually and simultaneously arrive at the same temperature. In neither the gas nor the metal is there any other known physical change during the superheating of the gas. If sufficient time for transmission of heat from the metal to the gas be allowed, the temperature will inevitably equalize in both. The weight of the metal cylinder with its piston and heads is enormously greater in comparison than the weight of the gas, but its specific heat is only about one-fourth that of the gas. Approximately, the cooling of any weight of cast iron through a given range of temperature would effect the heating of one-fourth of the same weight of ammonia through an equal range. The conclusion that only a very thin interior stratum of the iron is concerned in the cylinder superheating of air or ammonia, while entering a compressor cylinder, or in the cylinder condensation of steam during induction, has been generally accepted, and the preceding considerations render it probable that this view will never be successfully disputed. But the metal heats throughout its entire mass, notwithstanding. The action of a steam jacket is to lessen cylinder condensation by transmission of heat from the exterior to the interior surface. So the action of the cold-water jacket almost universally used on air and ammonia compression cylinders tends to lessen the superheating, but the transfer of heat from surface to surface proceeds in an opposite direction.

The quantitative effect of the cold-water jacket in lessening the superheating has not been made the subject of such thorough investigation as has been devoted to steam jacketing, and few, if any, reliable data upon which to base conclusions are available. But, when cool water in considerable quantity is constantly passed through the compressor jackets and issues therefrom with a notable elevation of temperature, it is sure that the effect of this transfer of heat from the inner cylinder surface through the cylinder barrel and heads, and thence to the water, must diminish, in a greater or less degree, the temperature of the inner surface, and so decrease its power to superheat.

Professor Denton's experiments were made with a seventy-five ton ammonia dry-compression machine. No one who has read his paper describing these tests in the transactions of the American Society of Mechanical Engineers, will question the skill and care with which they were conducted, or will dispute his determination of the superheating, 132.6 degrees F., as a matter of fact. We have already seen that, to account for this wholly by transference of heat to the gas from the interior cylinder surface, this surface must have an average absolute maximum temperature of 740 degrees F. at the beginning of the suction. The inflowing gas had a well ascertained absolute temperature of 485 degrees F. Suppose an interior stratum of the metal at 740 degrees falls in temperature through the same range as the gas is superheated. Then, at the end of the suction and just prior to the beginning of compression, the absolute temperature of the superheated gas is substantially the same as that of the cast iron in contact with it, and such temperature will be the mean of 740 degrees and 485 degrees, or 612.5 degrees, which accords remarkably with the absolute temperature, 617.6 degrees, in Professor Denton's table.

But if a notable quantity of heat is constantly passing out from the inner stratum of metal into the jacket water, it is certain that the temperature of that stratum cannot be a mean of highest and lowest temperature of the gas in the pump, and that a part of the superheating must be accounted for by another cause, or causes. Such causes may be found in the friction of the pump-rod and piston, in the constant beating of the poppet valves on their seats, and the friction of the gas itself in passing through ports. We cannot accept these causes as sufficient in the aggregate to counterbalance the cooling by the water jacket. Professor Denton's determination was 713 British thermal units per minute removed by the jacket in the experiments under consideration; and the mechanical equivalent of the heat so removed was 554,714 foot-pounds per minute. The power of the steam-engine was 2,395,800 foot-pounds per minute, and the total friction of the machine 18.6 per cent., or about 445,619 foot-pounds. It becomes evident from these figures that the heat removed by the jacket is in excess of that generated by the total friction of the machine, and therefore must be far in excess of the heat generated by the several frictions which can be possibly associated with the superheating of the gas during the suction period. The fact and the degree of the superheating are indisputable. The inference is irresistible that the principal cause is the transfer of heat from a thin interior stratum of the metal in contact with the gas; but the inference that other causes contribute to the observed results, seems equally unavoidable. It is impossible to conceive that, by simple contact, or any effect of radiation, the gas can ever be superheated to a temperature higher than a mean between the average temperature of the metal which imparts the heat and the minimum constant temperature of the gas during the inflow. It is impossible to conceive that, with a water jacket taking away 713 British thermal units per minute, the gas is superheated to even this degree. Of course a large percentage of the heat removed by the jacket is heat generated by the mechanical work of the compression, but during the suction period, the entire pump barrel being surrounded by cold water, we cannot be justified in supposing that the effect of jacket cooling in reducing the temperature of the inner surface is so small as to be negligible.

The subject involves many experimental and theoretical difficulties. Some recent experiments (which, at present, it is not permissible to cite more specifically) made to determine the extent to which a two-stage compound compression with intermediate cooling would lessen superheating, as compared with that in a single-stage compression system, have demonstrated that there is less superheating in the two-stage system; but the results were not so conclusive as expected, and further experiments will be needed before any reliable data can be deduced.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

I. A COMPARISON BETWEEN AMERICAN AND EUROPEAN PRACTICE.

By Franz Koester.

The current portion of Mr. Koester's study covers the general features of the design of large power stations—that is, the location, design of the structure, adaptation to the type of machinery selected, etc. Succeeding portions will discuss in detail the boiler-house and engine equipment. Mr. Koester has been intimately conncted with power-plant construction both in Europe and America, and has undertaken this review at the request of a number of engineers specializing in this work. The contrast between American, British, and Continental practice which runs through his discussion will be found of much interest; more important still, perhaps, are his indications of the possibilities of enormous savings in coal and water consumption, and his argument for more scientific methods of design and better guarantees on the part of manufacturers.—The Editors.

SINCE the general commercial adoption of electricity for lighting, railways, mining, smelting, and many and various other enterprises, a marked development in the central-station power plants has taken place. These power plants generate electricity from prime movers driven either by steam or by water. Power of the latter sort may be easily obtained in mountainous countries, such as California, Switzerland, Sweden, etc., where the energy is collected from the mountain lakes or streams, or at such falls as that of the Rhine, Niagara, or that on the Zambesi, the "Victoria Fall," the greatest in the world, where some 25,000,000 horse power may be easily developed. Although it is possible to-day to transmit electricity considerable distances from a central source to innumerable consumers, unfortunately there are so such water powers situated near the large cities, where the greatest demand for electric power exists. Take, for instance, the cities of New York, Chicago, London, Paris, Berlin, Vienna—all of which are obliged to generate electricity from the former source, i e, the production of steam from the latent energy in coal, and the utilization of that steam in generating power for either mechanical or electrical purposes.

The design of these steam power plants involves the study of a great number and variety of engineering apparatus, and it is therefore properly considered a special branch in itself. In Europe, especially

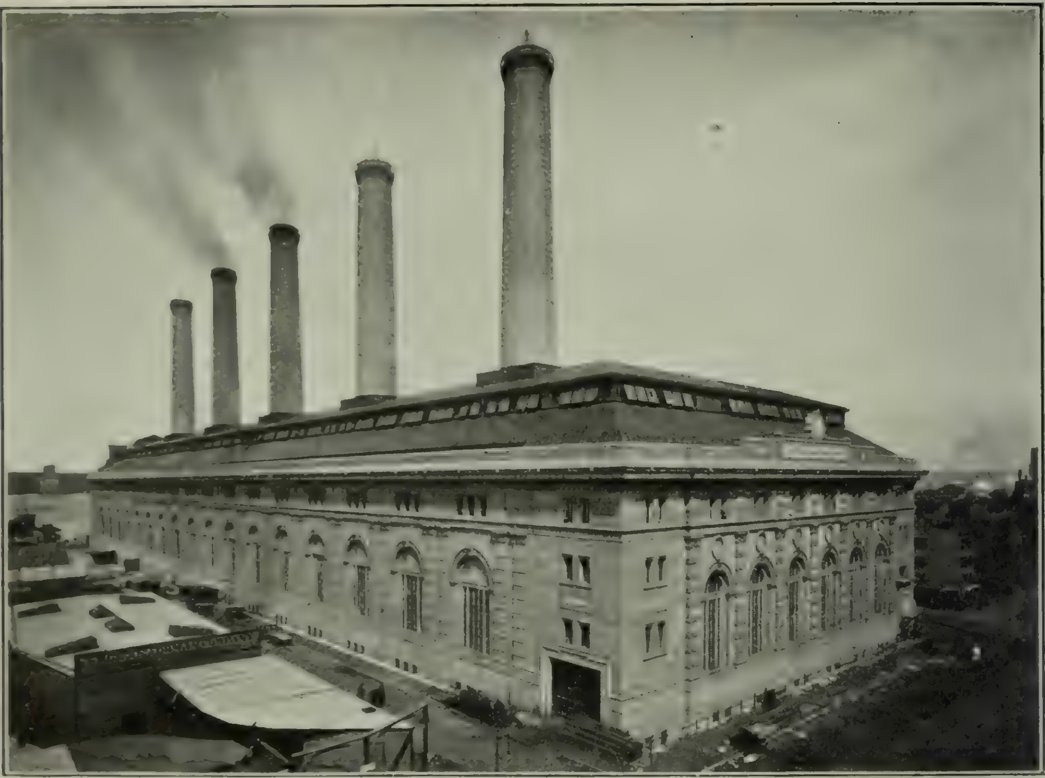


FIG. 1. THE INTERBOROUGH COMPANY'S NEW POWER HOUSE FOR THE NEW YORK SUBWAY.

on the Continent, where engineering work is strictly classified, and often by very definite lines, power-plant designing is a vocation of itself, the benefit of which in many instances cannot be overvalued as will be seen later. Quite different is the practice in the United States. Although there are many American engineering offices where the design of power plants is carried on, some of the most prominent plants in the country have been built by newly formed construction companies, employing one or two experts while the remainder of the force consists mostly of men untrained and inexperienced in this manifold branch of engineering. Could it be expected that a steel constructor, no matter how experienced, could design as economical or efficient a power plant as one who has devoted his entire time to this particular line of practice? It is natural that only a staff of engineers and draughtsmen specially trained in this line could assure the most skilful and thorough construction, not to speak of the scientific knowledge necessary for such an undertaking in order to secure the most economical results in operation. The question forces itself upon us why, on the continent of Europe. in a modern plant, a steam consumption of only 9 to 10 pounds per indicated-horse-power hour is obtained, while in England and America a consumption of 13 to 15 pounds is considered good practice. This superiority of some 50 per cent. on the part of the Continental plants may in certain cases be explained by the above mentioned facts, while in part it is due to the manufacturer and the power-plant manager.

The author, having had direct experience in the design of both small and large power plants, on both sides of the Atlantic, will endeavor to describe modern power-plant practice. The discussion is presented in fulfilment of the request of several power-plant engineers, who have desired especially a comparison between the design and the efficiencies of American and European plants.

Before the adoption of alternating current, when direct current was transmitted throughout the city, it was necessary to have the plant centrally located in order to facilitate a proper and uniform distribution. It was often found necessary to build several smaller plants to supply a single railway or lighting system. A good example of this is supplied by the city of Hamburg, 650,000 inhabitants.

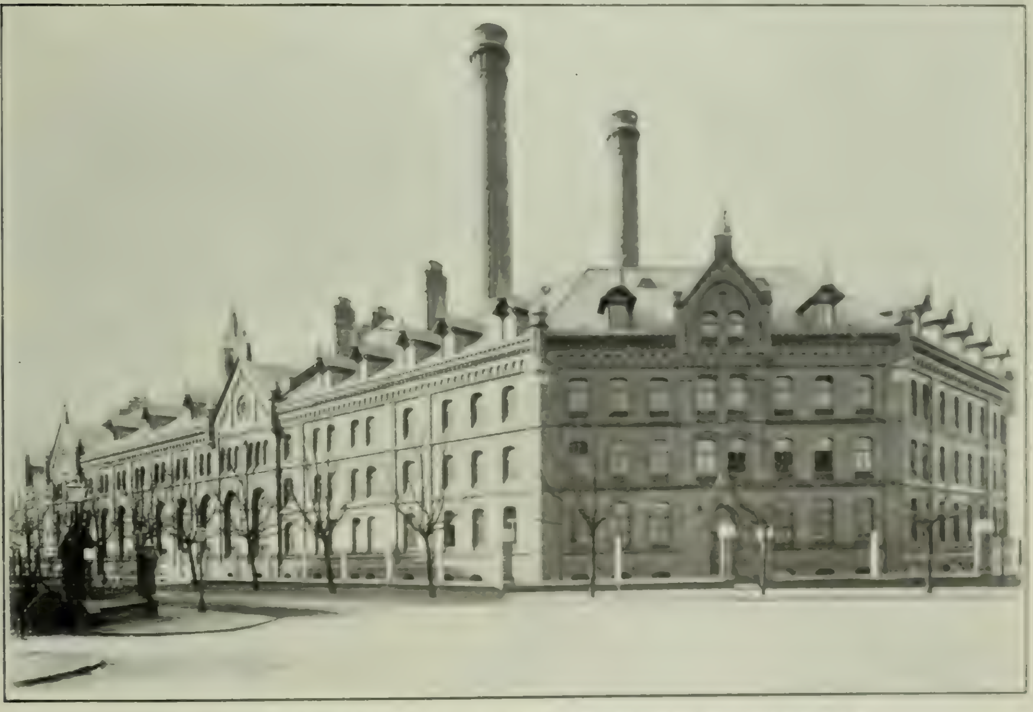


FIG. 2. THE BARMBECK PLANT IN HAMBURG, GERMANY.

Here the Schuckert Company built for the Hamburg Elektricitats Werke no less than five plants, located at proper distances apart and directly in the city. The aggregate output of these five plants is some 50,000 horse power, which today would be considered not excessive for a single plant. It must be remembered that some of these plants served the city with power and lighting at an early date, and in order to avoid changes in the existing equipment the same system was followed in the later plants.

With alternating current at high voltage, it is easily possible to supply large cities from a single generating plant. In northern Italy, the Valtellina Railroad with its present length of some 70 miles is supplied with power from a single source at 20,000 volts, 15 cycles. As we have today plants of 100,000 horse power and more (the New York Subway plant (see Figure 1) will have a maximum output of more than 130,000 horse power) it will be seen that the tendency is toward the adoption of a single central station. Not only has the size of the power plant been increased, but also the main units, steam turbines of 10,000-horse-power capacity being installed by the Brown Boveri Company to supply power and light to the city of Essen, Germany, and as I am informed, there are still larger turbine units in course of construction. The city of Vienna will in a short time have two 10,000-horse-power steam turbines installed in its municipal plant. Not only in turbine units has this enormous increase in size occurred, but as I understand, the Allis-Chalmers Company have submitted

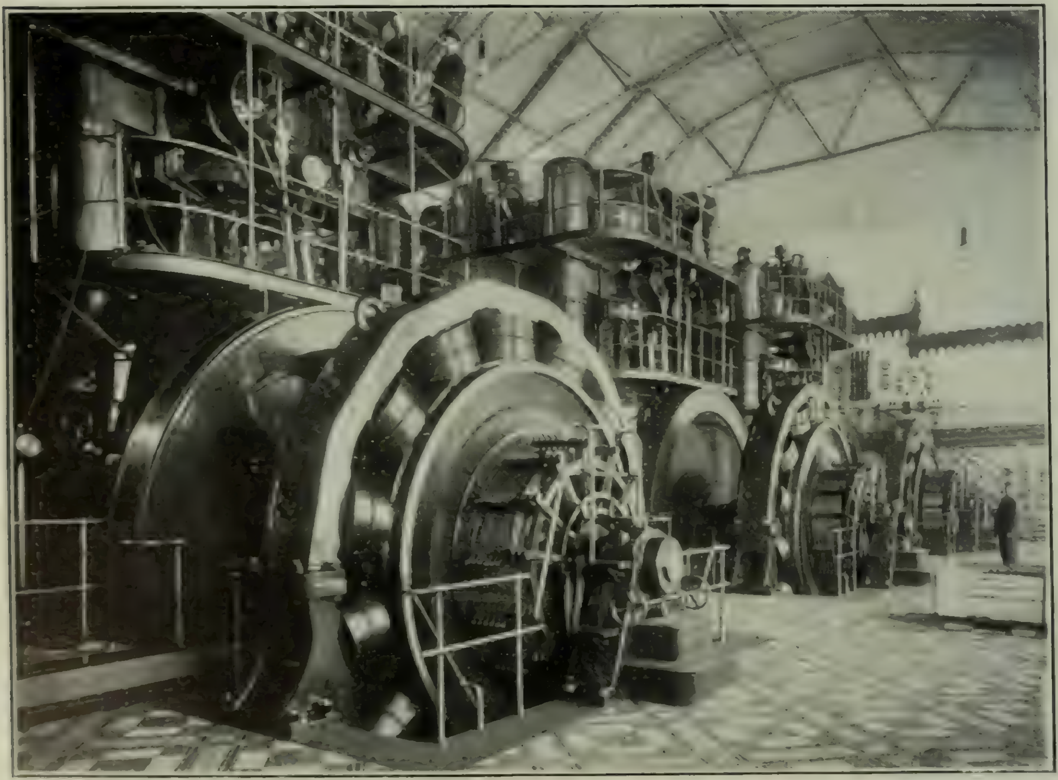


FIG. 3. ENGINES AND GENERATORS IN THE BARMBECK STATION, HAMBURG, GERMANY.

Schuckert & Co., Nurnberg.

FIG. 4. THE MUNICIPAL ELECTRIC STATION, MUNICH.

bids for 10,000-horse-power reciprocating engines to the New York Central & Hudson River R. R. Company. This is not the place to discuss the respective merits of the different sizes of prime movers, there being special features which must be taken into consideration for each special case.

FIG. 5. THE MUNICIPAL POWER STATION, VIENNA.

The location of the plant itself must be chosen, first, as close to the water front as possible, and second, with respect to the possibility of a railroad siding, these provisions being necessary for the economical handling of machinery, coal, etc. Not only does proximity to the water front allow of cheaper transportation, but a still greater convenience is the accessibility of a sufficient supply of water for condensing purposes, which in large plants is no small item; and further, when this water is fit (either directly or after purification) for boiler-feed water, an enormous saving in cost of maintenance accrues. By the use of alternating current the plant may even be located in a suburb, where land is cheap; but it often happens that the designer is forced to locate the plant directly in the city, causing in many cases a deterioration in the value of the surrounding property. While city land on the continent of Europe is comparatively cheap, many plants are found in the suburbs; in either case the engineer has to build a plant to suit the artistic tastes of the resident property owners as well as himself. The accompanying illustrations will furnish ample examples. The Hamburg plants, Figure 2, are all in the city. The municipal plants of Munich, Figure 4; Vienna, Figure 5; and Mainz, Figure 6, are all in the suburbs and speak for themselves. Not only do the exteriors of these European plants present an artistic effect,

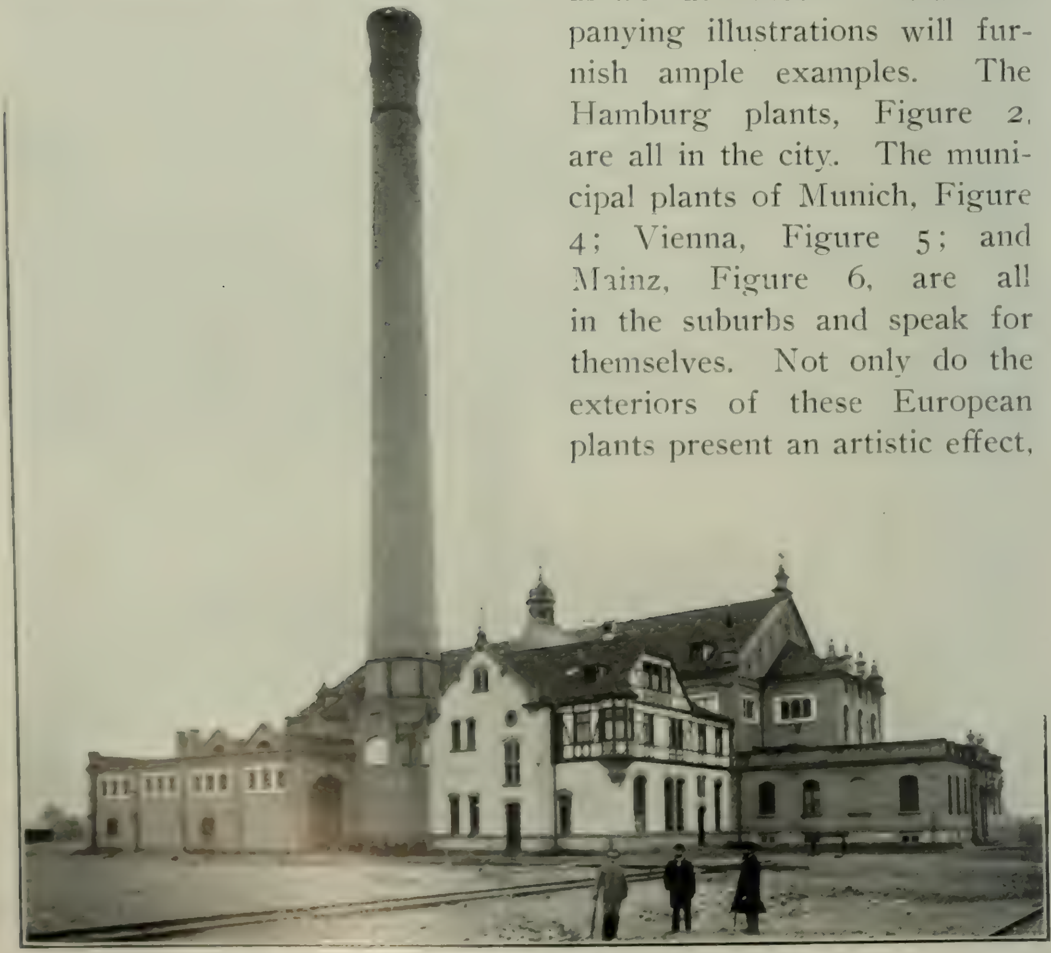


FIG. 6. MUNICIPAL PLANT AT MAINZ, GERMANY.

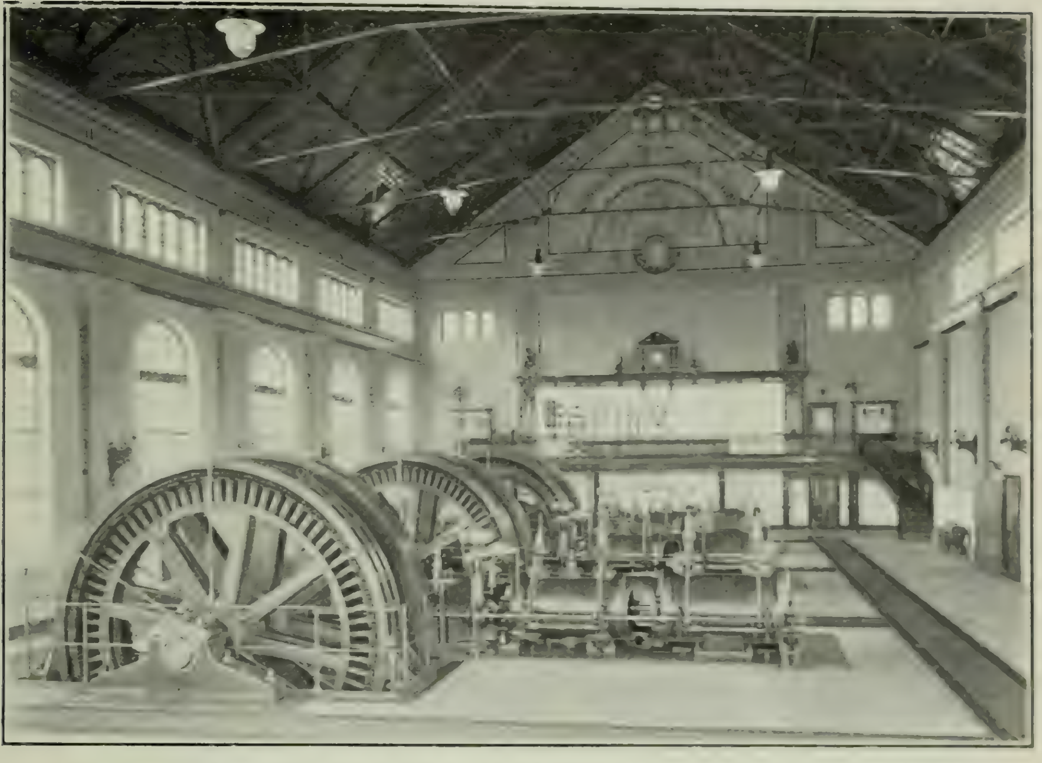


FIG. 7. GENERATING SETS IN THE MUNICIPAL POWER STATION, MAINZ.

but the interiors also present a pleasing appearance as will be seen in Figures 3 and 7, as well as in other illustrations.

A still more important consideration is that of the smoke nuisance, which, however, may be entirely overcome by the use of properly designed smoke consumers. Complete combustion in the furnace is now attainable, and this in addition to overcoming of the smoke nuisance also increases the efficiency to such an extent as soon to pay for the additional first cost of the apparatus.

The most favorable arrangement, here as well as abroad, has been found to be the location of the engine room and boiler room side by side, thus allowing in most cases the shortest steam-pipe runs, as well as many other advantages. By placing the boiler and engine rooms end to end, a long steam run is involved, and this is one of the greatest disadvantages, especially where superheated steam is employed. With the adoption of the steam turbine as the prime mover, making a compact layout, the turbine room is much smaller than the boiler room, provided the much used horizontal water-tube boilers are installed. In Europe as well as in America, in the design of steam-turbine plants, owing to the possibility of a compact layout in the turbine room, recent practice seems to depart from that just indicated, i. e., placing boiler and engine room side by side, divided by

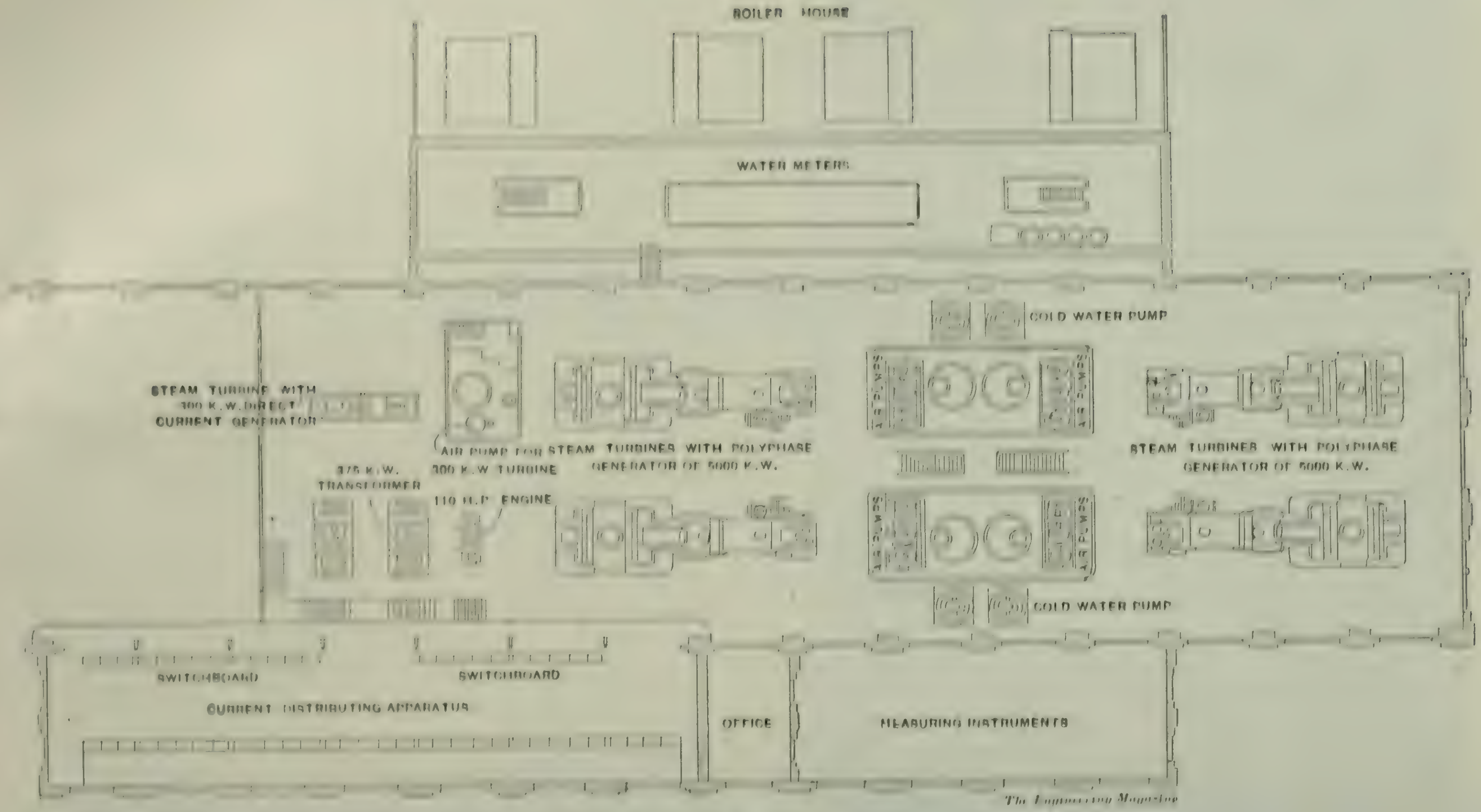

BOILER HOUSE
WATER METERS
COLD WATER PUMP
STEAM TURBINE WITH 300 K.W. DIRECT CURRENT GENERATOR
AIR PUMP FOR 300 K.W TURBINE
STEAM TURBINES WITH POLYPHASE GENERATOR OF 5000 K.W.
AIR PUMPS
STEAM TURBINES WITH POLYPHASE GENERATOR OF 5000 K.W.
375 K.W. TRANSFORMER
110 H.P. ENGINE
COLD WATER PUMP
SWITCHBOARD
SWITCHBOARD
CURRENT DISTRIBUTING APPARATUS
OFFICE
MEASURING INSTRUMENTS
The Engineering Magazine

FIG. 8. PLAN OF THE ST. OUEN PLANT, PARIS.

a single wall. For example, the Carville plant, Figure 9, below, supplying power for the North Eastern Railway in England, also the new Public Service Corporation plant still under course of construction in New Jersey; in both of these cases the boiler houses lie at right angles to the turbine rooms, thus providing four or more rows of boilers, depending upon the number of prime movers and the length of the turbine room. A similar layout will also be found in the St. Quen or St. Denis plant still under course of design of Paris, which will furnish the power for the city railway. This plant will be equipped with four main units of 5,000-kilowatt Brown Boveri-Parsons steam turbines, which will be supplied with steam from twenty boilers placed in four rows at right angles to the generating room. It may therefore be assumed that the compactness of the turbine room may create a revolution in the design of the boiler house, introducing a more general use of the vertical type of boiler. To avoid the adoption of this type of boiler, a two- or three-story boiler house may be constructed, but there are countries (such as France) where the building laws prohibit the use of more than one story of boilers. French engineers have therefore adopted a B. & W. marine-type water-tube boiler, which on account of its small floor space is well adapted for use in conjunction with steam turbines; but by allowing two exceedingly wide passages of some 30 feet between the rows of boilers, there are only 4 square feet of heating surface per square foot of boiler-house floor, compared to the Chelsea plant (Figure 11 and 12) supplying power for the electrification of the

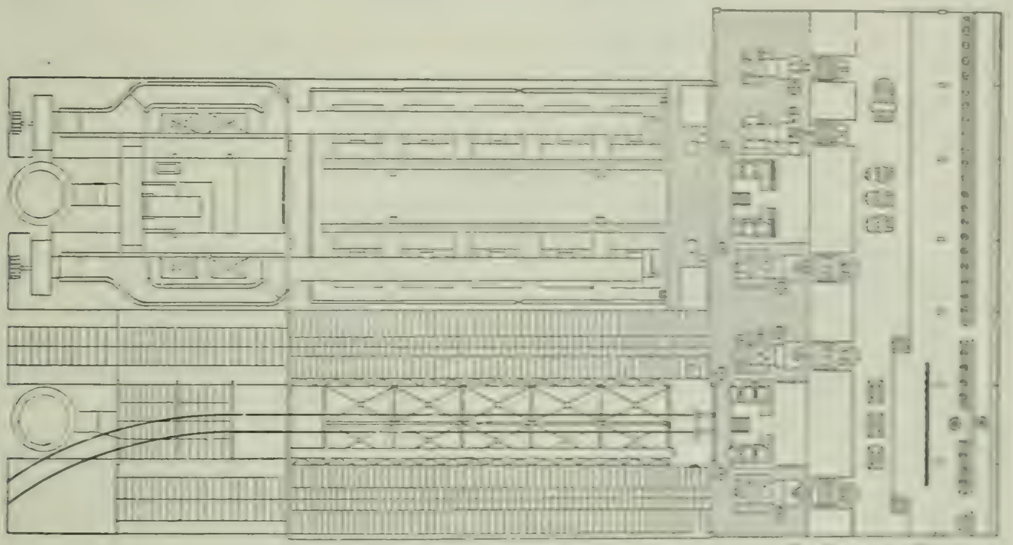

The Engineering Magazine.

FIG. 9. CARVILLE POWER STATION, NEWCASTLE, ENGLAND

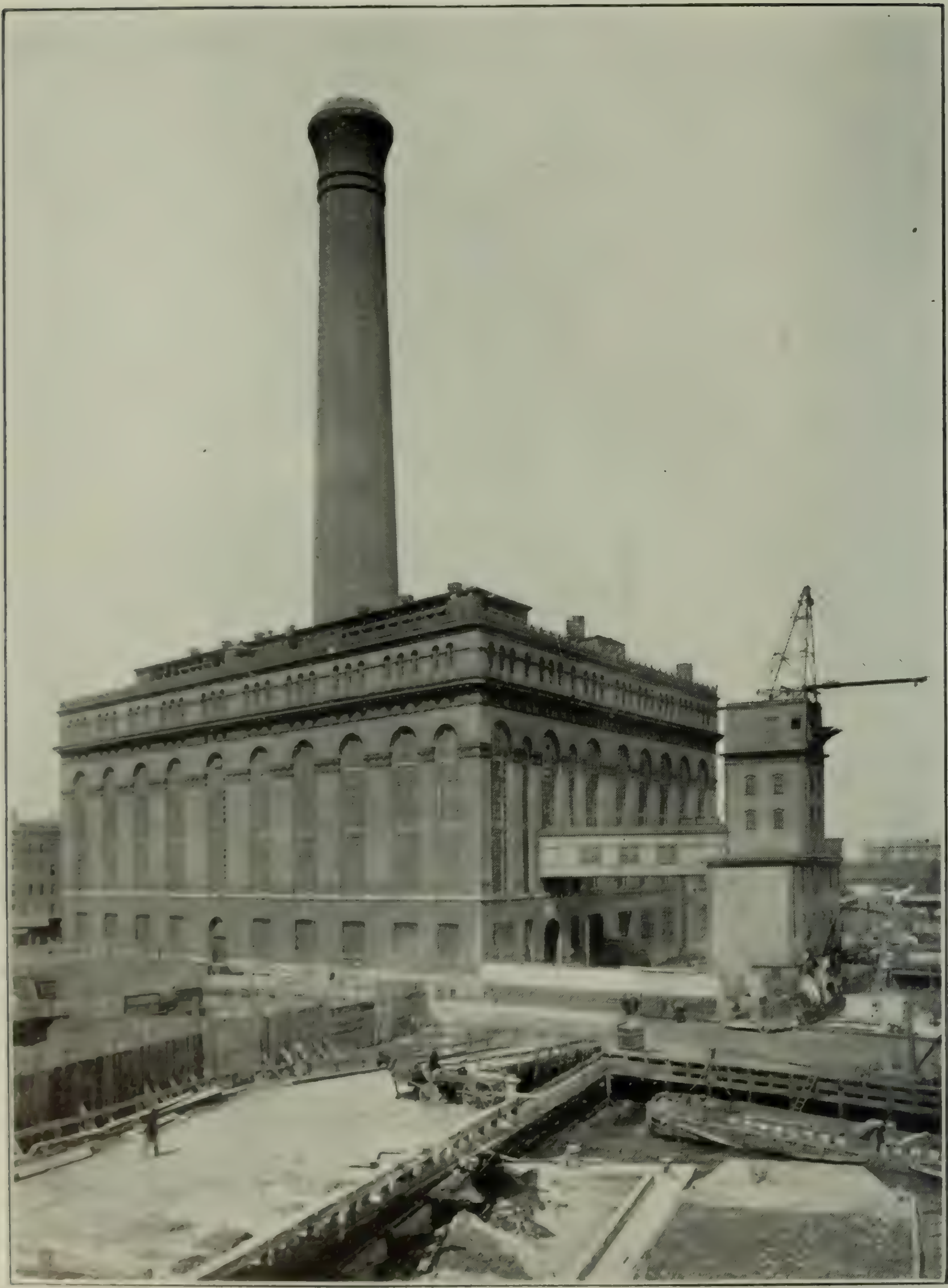


FIG. 10. POWER HOUSE OF THE METROPOLITAN STREET RAILWAY SYSTEM, 96TH STREET AND EAST RIVER, N. Y.

By courtesy of the Mead-Morrison Co., N. Y. Their coal-handling installation is seen on the right.

London Underground Railway; this consists of two tiers of B & W stationary boilers with Green economizers, in which 1 square foot of floor space (on each floor) gives 4.3 square feet of heating surface.

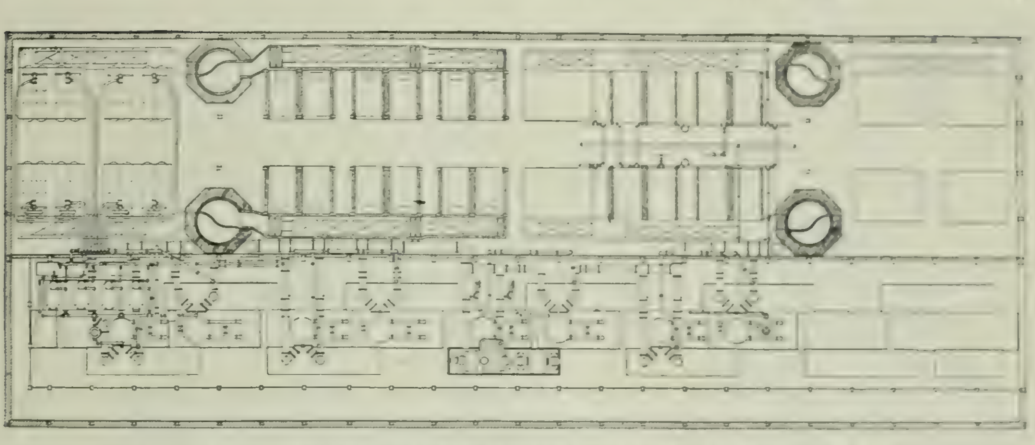


FIG. 11. CHELSEA STEAM-TURBINE PLANT, LONDON. PLAN.

A still greater result—and probably one of the best in this direction—is that of the design of the New York Rapid Transit power house by Mr. John Van Vleck. The result of 7.5 square feet heating surface per 1 foot floor space is due to locating the economizers on the second floor, as will be seen in the accompanying illustration, Figures

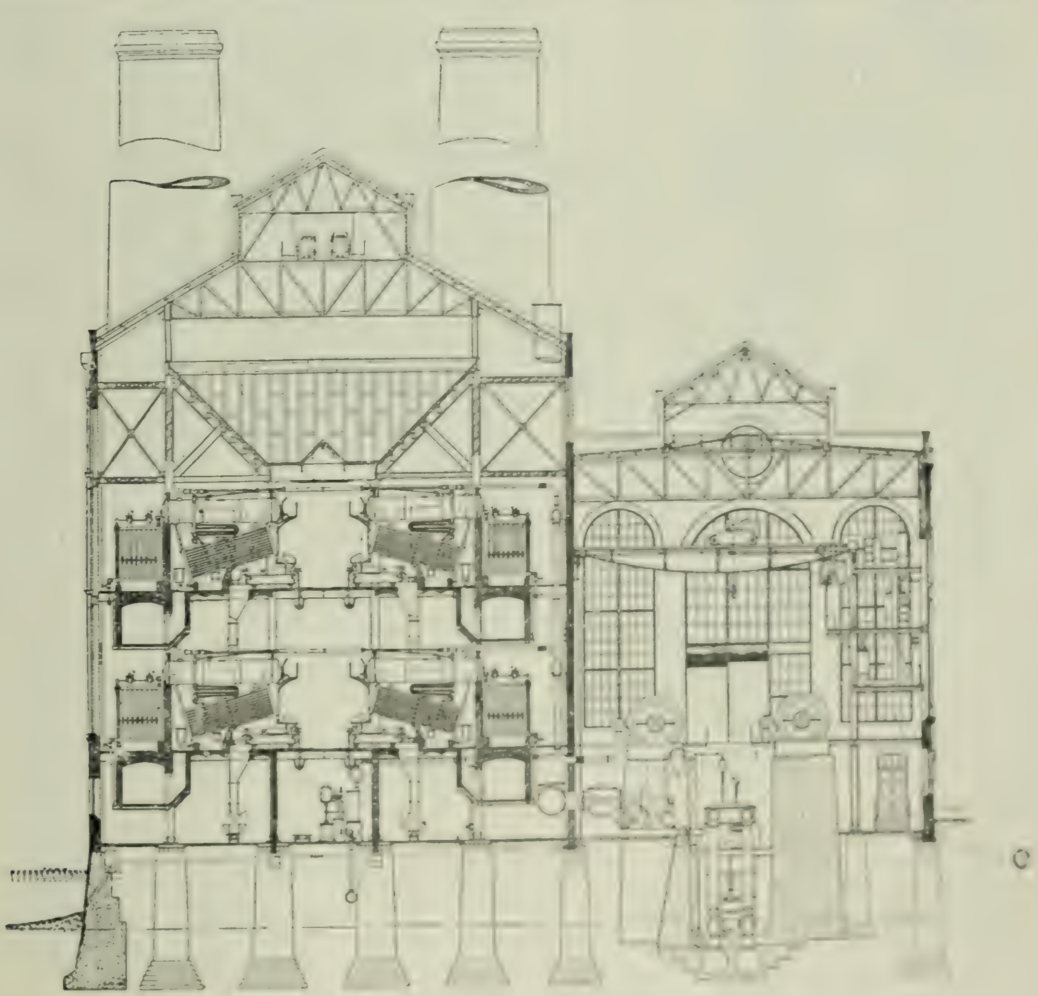


FIG. 12. CHELSEA STEAM-TURBINE PLANT. SECTION.

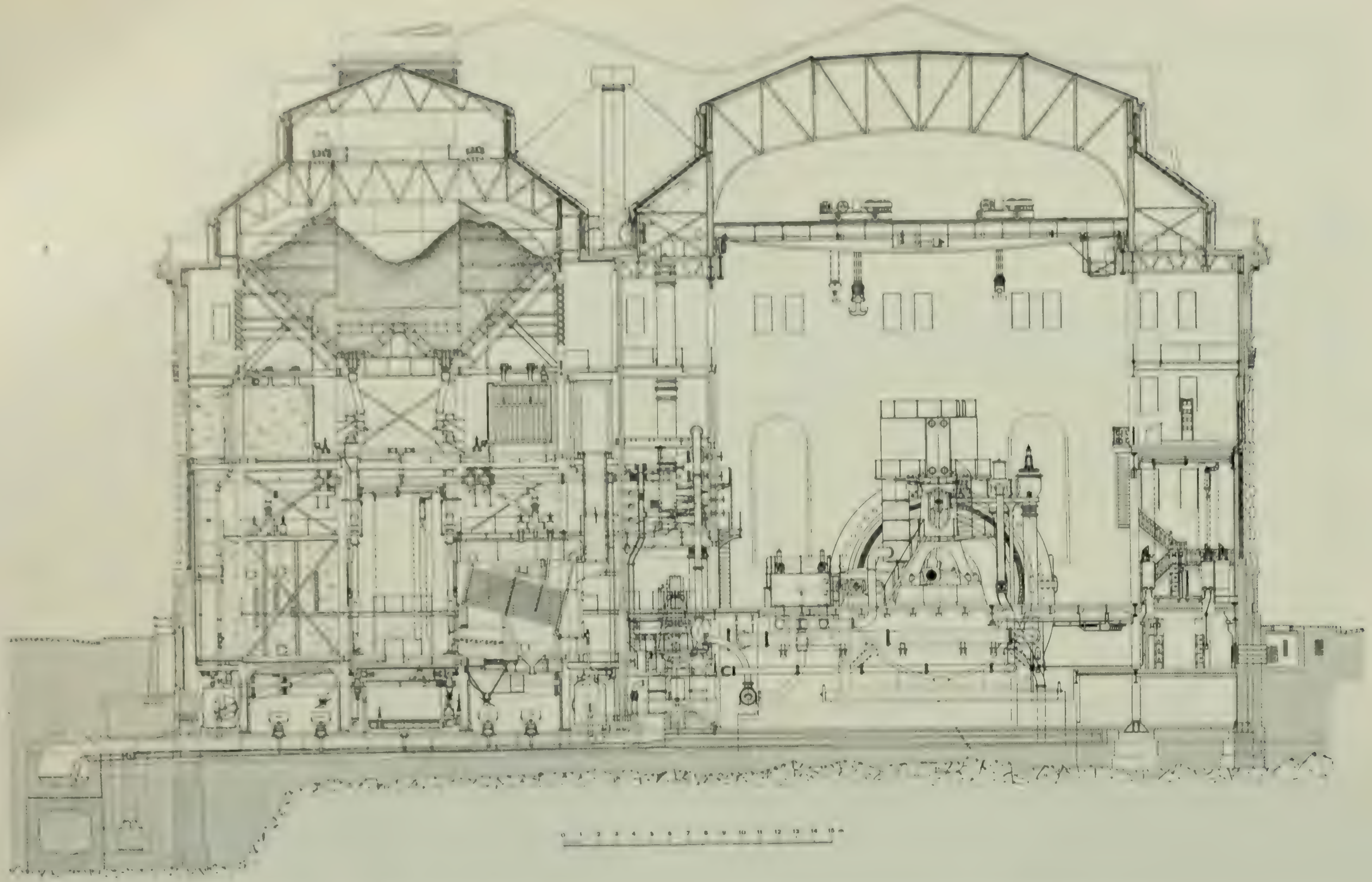
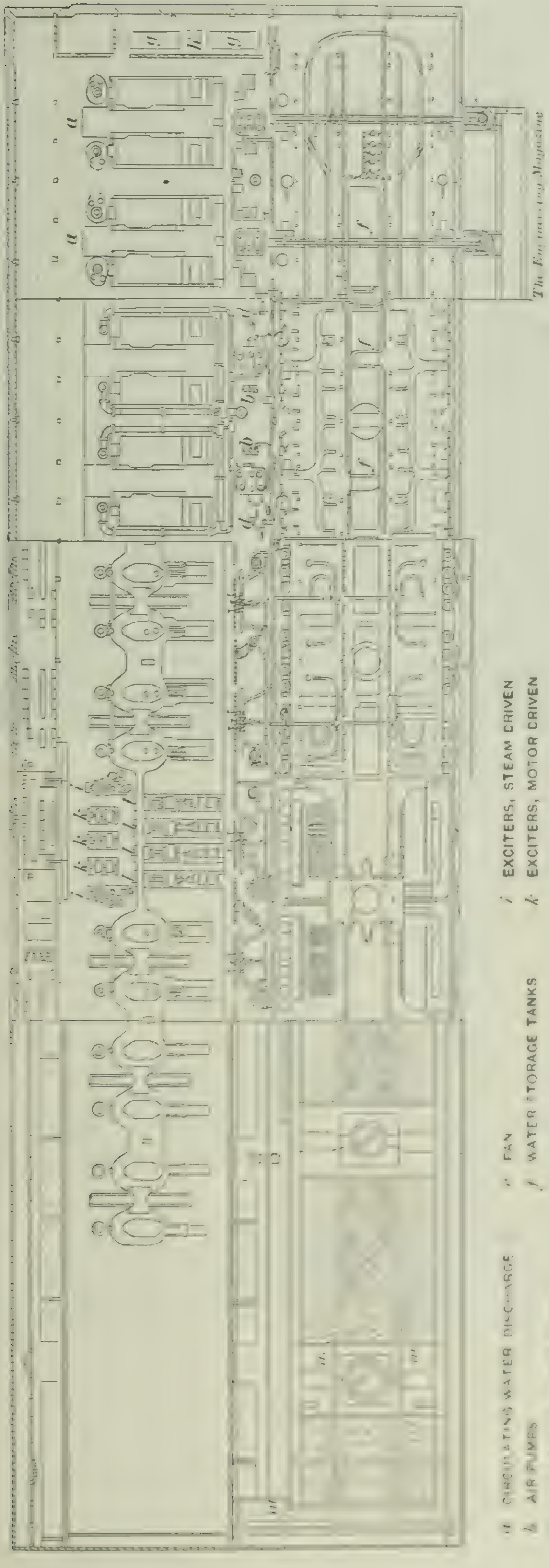


FIG. 13. SECTION OF THE "SUBWAY" POWER-HOUSE OF THE INTERBOROUGH CO., NEW YORK.

13 and 14; furthermore, the six smokestacks of this plant are carried on steel columns above the boiler room. The construction of many brick-lined steel flues necessary to carry the smoke to the stacks is exceedingly expensive.

It may be of interest to give here the weights of steel required for the columns, floor beams, etc., in two prominent recently constructed power plants—the Chelsea plant, of London, and the Interborough Rapid Transit plant of New York City. Both of these boiler plants are constructed in two tiers, over which are placed the coal bunkers, which are of practically the same capacity, about 15,000 tons each. In the former, on account of the adoption of the steam turbine as the prime mover, the generator room is both lower and narrower than the boiler room, although of the same length.



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a CIRCULATING WATER DISCHARGE
b AIR PUMPS
c CIRCULATING WATER PUMPS
d BOILER FEED PUMPS
e FAN
f WATER STORAGE TANKS
g OIL TANKS
h OIL PUMPS
i EXCITERS, STEAM DRIVEN
k EXCITERS, MOTOR DRIVEN
l STEAM TURBINES
m COAL CONVEYOR

FIG. 14. PLAN OF THE INTERBOROUGH COMPANY'S SUBWAY POWER PLANT, 59TH ST., NEW YORK.

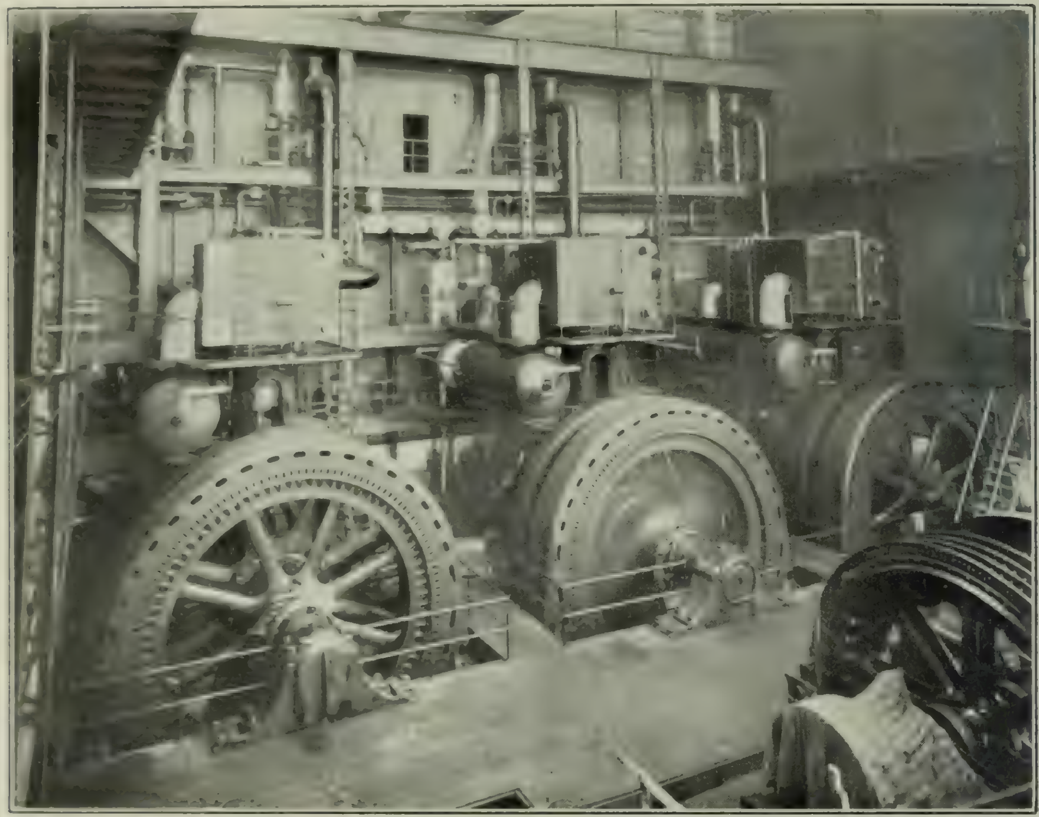

FIG. 5. INTERIOR OF THE POWER STATION, CITIZENS' HEAT, LIGHT, AND POWER CO., ROCHESTER, N. Y.

Three vertical cross-compound Corliss engines, direct-connected to 1,360-Kilowatt alternators. Designed and built by Southwark Foundry & Machine Co., Phila.

and the total area covered by the entire plant is about 77,550 square feet; in the latter plant, where reciprocating engines are installed, the engine room is wider than the boiler house and the same height, the entire plant covering an area of about 138,600 square feet. The former is designed for an ultimate capacity of ten 5,500 kilowatt turbines and one 2,700-kilowatts, making a normal total capacity of 57,700 kilowatts. The New York plant is constructed to accommodate twelve units similar to the nine already installed, which could give a normal total capacity of 72,000 kilowatts. The total amount of steel in the Chelsea plant, 6,000 tons, gives .077 tons per square foot of power-plant area, while the New York Subway plant with 12,300 tons of steel gives .088 tons per square foot, about 14 per cent. more than the former. Comparing them according to the kilowatt output, the former has 0.105 tons per kilowatt and the latter 0.170 tons per kilowatt, an increase of 67 per cent. It must be borne in mind that the six smoke-stacks, weighing 1,175 tons each, are supported by steel columns, which at the same time support the boiler-room floor, etc., but it will be seen that the additional steel for this purpose is practically negligible. The cost of the steel in the New York plant is about 12 per cent. of the total cost of construction.

In regard to steel construction, I should mention that the art and science of this branch of engineering consists of covering an area with the smallest amount of steel which will support safely the given load.

On the continent of Europe, power plants are usually constructed of one-story and the floor-space efficiency is not of vital importance on account of the cost of land. An exception to this system is that of the Berlin Underground and Elevated Railroad power station, which is very similar to common American practice, particularly to the Duane Street power house of the New York Edison Company, in which the boilers are located directly above the engine room. A typical Continental power plant is shown in Figures 16 and 18, which represent one of the Vienna twin municipal plants,* designed by the Schuckert Company, who with the Berlin Allgemeine Elektricitäts Gesellschaft and the Siemens Companies have built many similar plants.

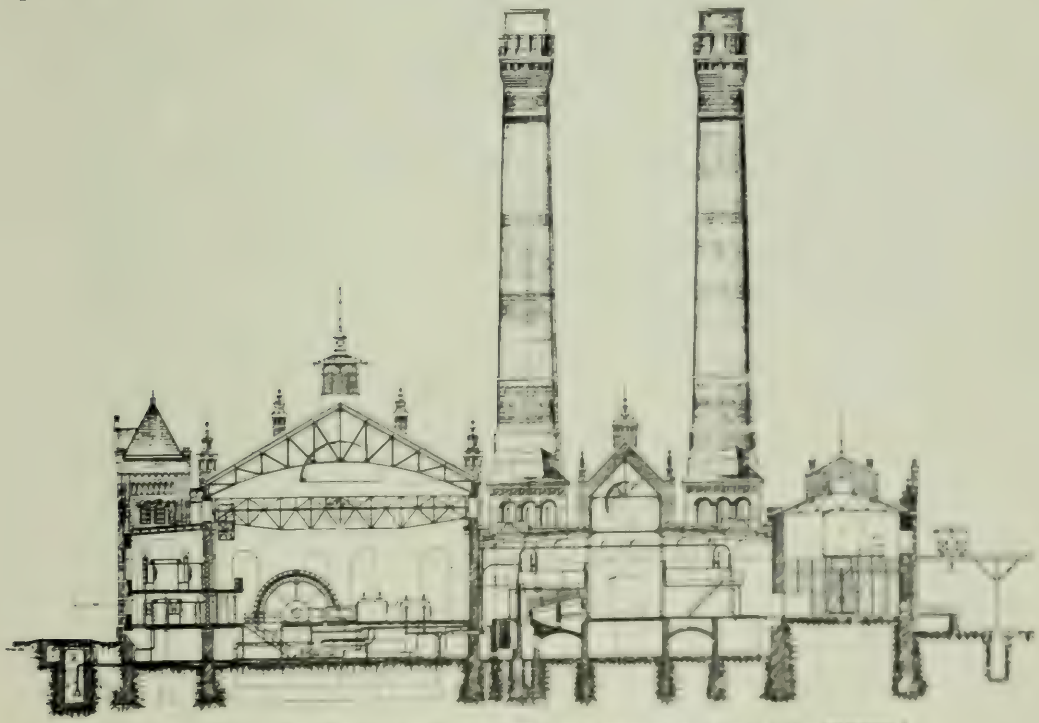

FIG. 16. CROSS-SECTION OF RAILWAY POWER PLANT, VIENNA.

It often happens that plants must be installed in a muddy locality, when it becomes necessary not only to give the engines and boilers solid foundations, but the foundation of the entire plant must be of solid construction, which may be accomplished by driving piles and

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* Franz Koester—*Electrical Review*, Jan. [illegible] 1904.

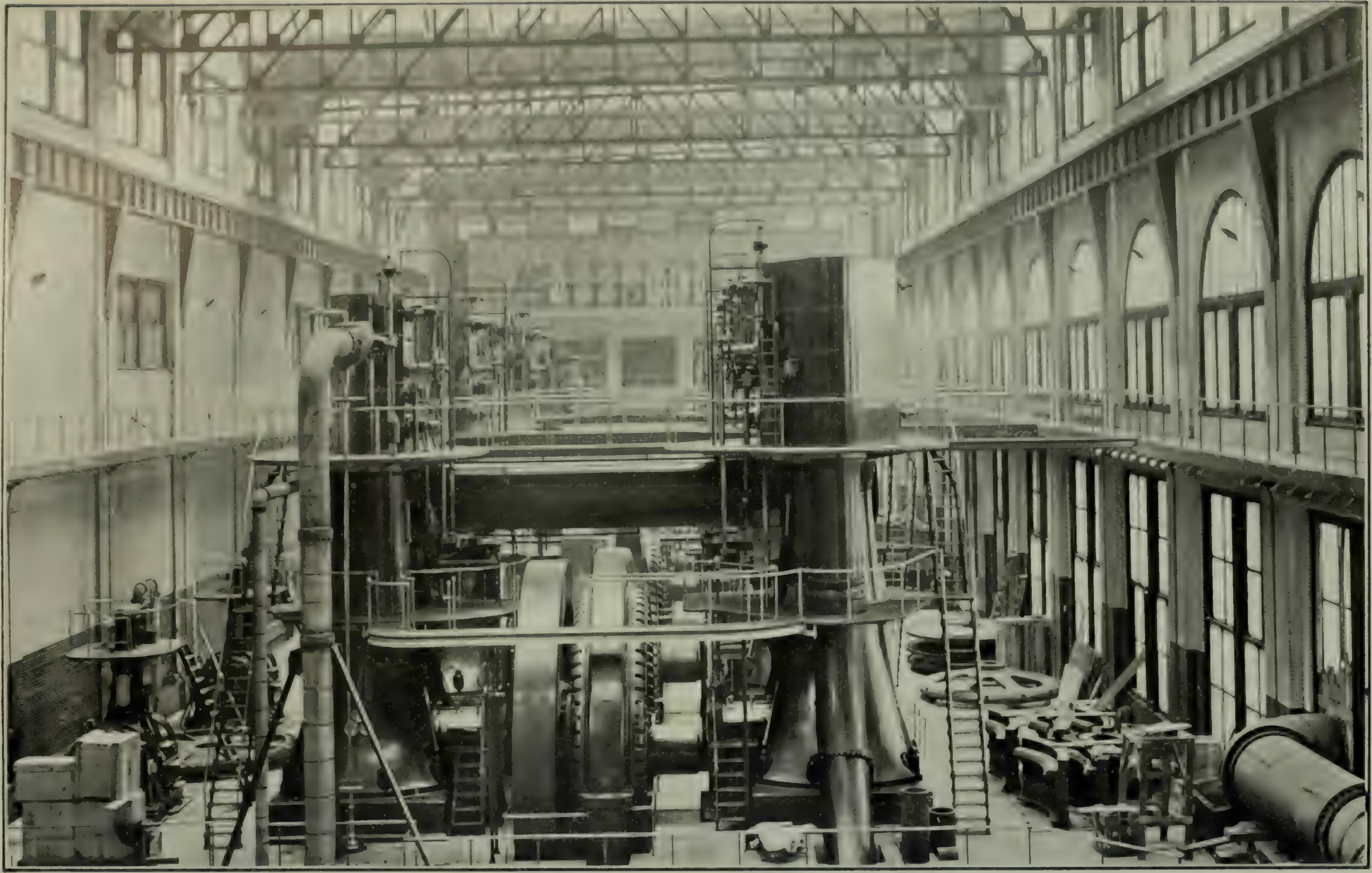

FIG. 17. AN EXAMPLE OF A MODERN AMERICAN CENTRAL STATION INTERIOR.

The plant of the Union Light and Traction Co., St. Louis, Mo. Three 3,500-horse-power and two 2,500-horse-power Allis-Chalmers vertical cross-compound engines.

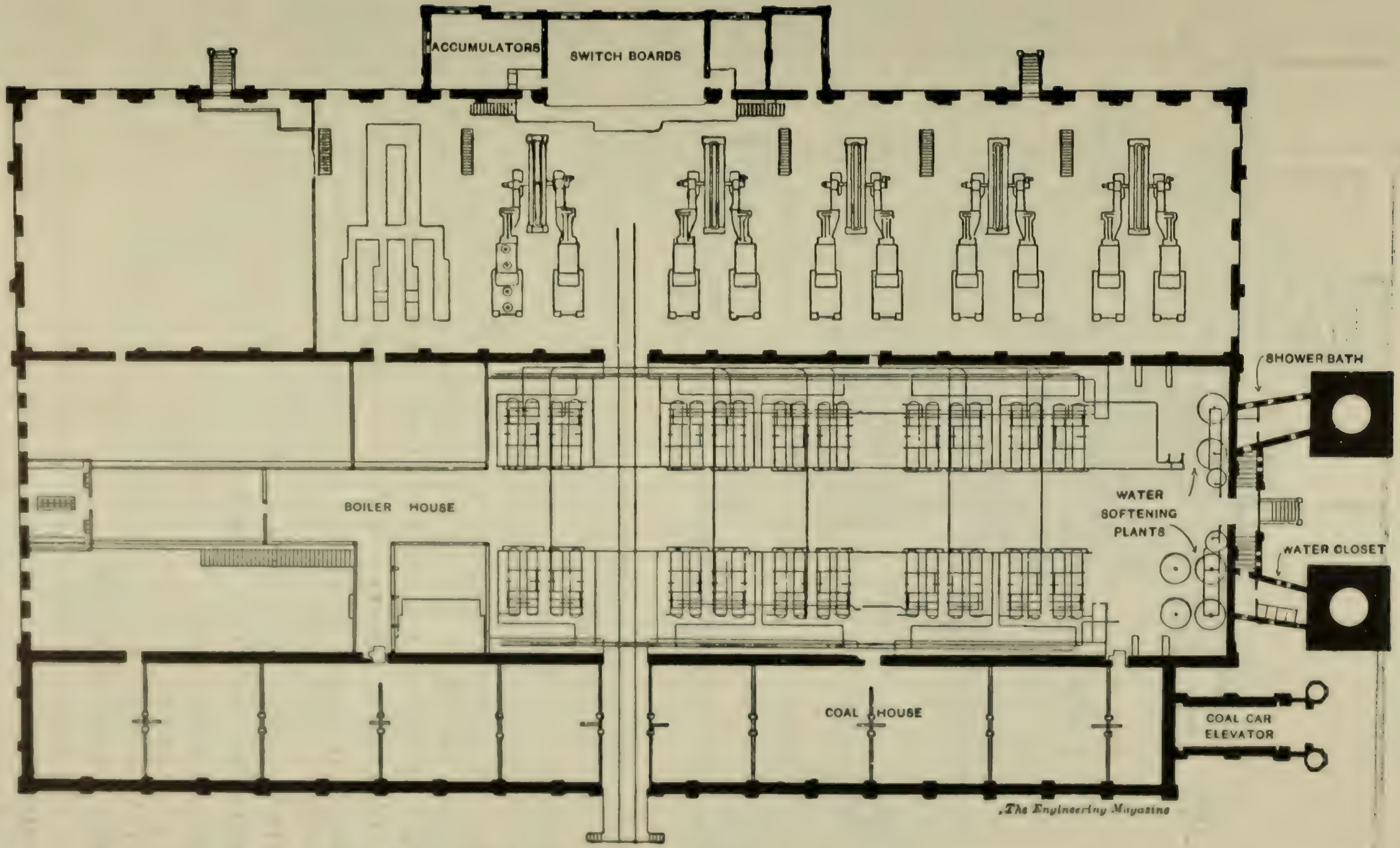

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FIG. 18. RAILWAY PLANT OF THE VIENNA MUNICIPAL INSTALLATION.

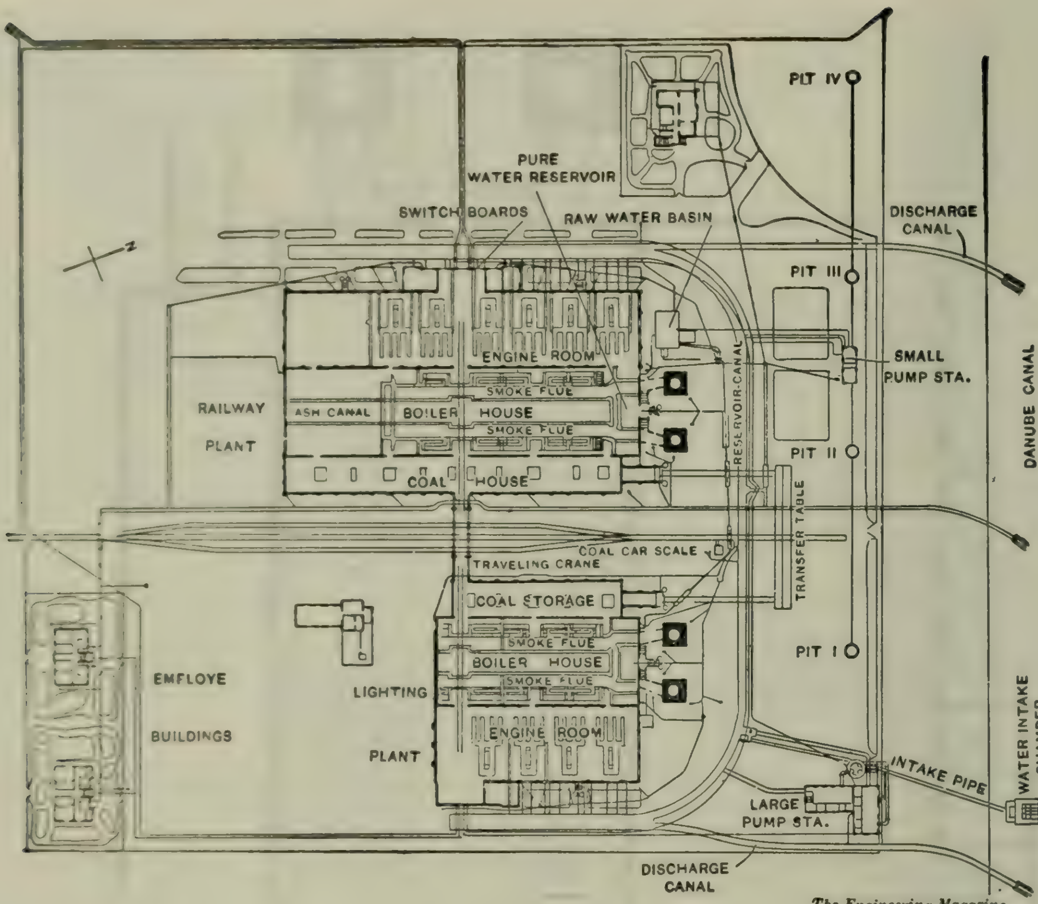

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FIG. 19. GENERAL PLAN OF TWIN MUNICIPAL PLANT, VIENNA.

re-enforcing them with iron rods or beams, thus preventing ultimate cracking of foundations or walls by uneven settling. This system has not always proven satisfactory, however, as the case of a Holland plant will show. This plant was built on piles driven in soft muddy ground, and at the end of a year it was discovered that the entire plant had moved a distance of about two inches in the direction of rotation of the engines. In order to prevent an occurrence of this character, engines with broad bed plates may be chosen and installed so that alternate units revolve in opposite directions. On the Continent large office equipments for the management of the plant and also the railway or lighting system are often found directly in connection with the power plant. Where these plants are located in the suburbs, it often occurs that separate buildings are supplied by the company for the superintendents and operators, and also for a store, as example the Vienna plant, Figure 19.

The following section of this study, next month, will deal with the boiler plant and its auxiliaries in the way of coal and ash-handling machinery, stokers, mechanical draft appliances, etc.

COST KEEPING IN GENERAL CONSTRUCTION AND CONTRACT WORK.

By A. W. Buel.

III. SOME ELEMENTS OF AN IMPROVED SYSTEM FOR EXTENSIVE WORKS.

Mr. Buel concludes, in this issue, the discussion of cost-keeping methods in contract work which he began in our March number and continued in May. It has been with him largely a labor of love—carried on amid the heavy burdens of his professional work because of his keen interest in the subject and his strong desire to see it advanced to a plane of sounder method and more scientific study. We are glad to say that the great purpose of awakening intelligent interest in the matter has been accomplished, and we shall be able to follow Mr. Buel's papers with others by engineering contractors who are in daily contact with these problems of cost determination and analysis. A very important contribution to the subject by one of the best known engineers in the country will appear in THE ENGINEERING MAGAZINE for September.—THE EDITORS.

THE difficulties quite generally responsible for failures to secure satisfactory results from cost keeping on general contract work may be classified under three heads.

1. Lack of initiative talent in the design, adaptation, and correction of the methods.

2. Lack of the requisite intelligence and force to make the records complete and keep them posted up to date.

3. Difficulty in collecting, analyzing, and segregating the great mass and complication of figures encountered on large works.

The first of these conditions can be met by the employment of consulting experts, either temporarily for the inauguration of a system, or continuously for advice as difficulties arise and modifications are required to meet new conditions. On very large works the employment of auditors or chief accountants of sufficient calibre to devise good systems and keep them up is justified and advisable.

The second difficulty could not exist for any length of time in a well managed organization, and where it does exist, it is a discredit. It is rather remarkable, not that it is so often encountered, but that a good many contractors admit it. In many, if not the majority, of such cases, the real difficulty is due more to the lack of initiative, direction, and encouragement on the part of the management than to any deficiency on the part of the employees, either in intelligence or force. Where incapacity of the employees actually exists, it is due to false economy and the remedy is to employ better men and pay them what they are worth.

The larger and more complicated the work, the higher should be the pay of the accountants and time keepers in order to secure and hold competent men. But on the other hand, the larger and more complicated works can well afford to carry the burden, and the percentage of expense for auditing and accounting should not be greater than on small works. In reality it should be less, were it not for the fact that on large and varied works cost keeping has additional functions to perform that are not required on small undertakings, where all the men and operations are practically under the eye of the manager. These additional functions consist in segregating the costs in more ways—giving a more complete analysis—than is generally necessary on the smaller works, and this somewhat increases the amount of work. As has been pointed out in a previous article of this series,* there will generally be found on any contract job, large or small, men of sufficient intelligence and reliability to co-operate in keeping costs under proper direction, provided the system is properly adapted to the conditions.

It remains to consider the third difficulty—that of the large amount of arithmetical and clerical work involved in distributing cost records and reducing the results to useful forms. This does not apply to contract work where the number of men employed is not large and where the operations are simple. For such cases, the system used by the Terry and Tench Company, and described in the May issue of THE ENGINEERING MAGAZINE, offers a very satisfactory solution with the minimum amount of clerical work, and one that can be easily adapted to the requirements of any contracting business where the operations are not of very great magnitude nor very complex.

There is, however, very little doubt that on very large works, the mere contemplation of the number of figures and amount of tabulating and accounting involved in keeping costs with full distributions has, in many cases, deterred the management from attempting it; or if they have made the attempt, the results have been so long delayed as to lose most of their value. It is the main purpose of the present article to show how such large masses of accounts, figures, and computations can be handled by a relatively small force and at such reasonable expense as to be entirely justifiable, without in any way curtailing or prejudicing the results. The following illustrations do not by any means form a complete system, nor even connected parts of a system, but are presented simply as elementary units which may be made use of, in whole or in part, in devising a system for, let us assume, a large contract for railroad construction.

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* THE ENGINEERING MAGAZINE, March, 1905, page 974.

To begin with, a set of rules or regulations will be drawn up and issued to all employees concerned, concisely stating how each and every transaction is to be entered in the books or forms provided, and how and when the returns are to be made to the general office or auditor. It will be a great assistance if a complete example of each form is filled out to accompany the rules or instructions.

Embodied in these rules and regulations of the auditing department, and composing a very important part thereof, should be an analytical list of all accounts, with distribution numbers assigned to each. These should be printed in pamphlet form, 6 inches by 9 inches, and issued to all superintendents, accountants, and time keepers. Where foremen are charged with reporting the distribution of labor, they should be supplied with a copy. The following arrangement and schedule,—taken from the System in use by MacArthur Brothers Company, was devised by the Everett Audit Company.

General Expense.—"The general expense of the company is divided into four departments, and designated by these prefixes:—

Offices.	Departments.	Initial.
Chicago	Executive	CE
"	Maintenance	CM
"	Accounting	CA
Contract	Operating	(Special List)

"The Executive Department includes the salaries of the general officers such as the president, vice-president, secretary, treasurer, assistant secretary, and any clerks or stenographers directly connected with the work of this department; the office expenses pertaining to this department; also all the general expense of the company that is not chargeable to a contract office, or some other general department.

"The Maintenance Department includes the salaries and expenses of the civil engineers, purchasing agent, master mechanics in Chicago office; the office expense pertaining to this department; also the general expense of the employees of this department, such as traveling expense, etc. Also, as a sub-department, the expense, etc., of the McCook shops for the general repair and storage of plant equipment.

"The Accounting Department includes the salaries of the auditor, accountants, clerks and stenographers in Chicago office required in making or keeping the general records of the company; the office expense pertaining to this department; also the general expense of the employees of this department, such as traveling expense, etc.

"Each contract office will be given a special 'prefix' consisting of two 'initials' or letters. (See list.) This department includes the salaries of the superintendents, assistant superintendents, engineers, clerks, and stenographers engaged on the contract, and the record of each contract is to be kept as a separate and distinct account, so that each contract report shall show the actual gain or loss for the same; the office expense in connection therewith; also any sundry general expense pertaining to and directly connected with that contract."

VOUCHER DISTRIBUTION.

CONTRACT OFFICES.

Initial Prefix.	Contract No.	Name of Contract.
CL	1	Clinton
CL	2	Clinton
TH	3	Thebes
FR	4	Froemsdorf
FO	5	Frisco
HM	6	Hawkins Mines
BL	7	Pine Bluff
BD	8	Bloomfield
ZE	9	Zeta
NW	10	St. Louis-Northwest'n
KC	11	Kansas City-St. Joe
NF	12	Newton Falls
NV	13	Pinckneyville
AD	14	Ada
HO	15	Hillsboro
SR	16	Sand Ridge
CV	17	Curve—Atoka
SN	18	Sutton
CC	18	Sutton—Coal & Coke
ZA	19	Zanesville
MA	20	Pere Marquette
AL	21	Alliance
SH	22	Power House—St. Louis
YA	23	Yarborough
WC	24	Webster City
EL	25	Elkhart
CU	26	Curwensville
CF	27	Cuyahoga Falls
CD	28	Cumberland
LD	29	Litchfield

GENERAL EXPENSES.

Expense Items	Distribution No.
Salaries.	
Superintendent	1
Assistant Superintendent	2
Engineers	3
Clerks—Timekeepers	6
Stenographers	7
	8
	9
Office Expenses.	
Printing—Stationery	10
Office Supplies	11
Postage	12
Telephone	13
Telegrams	14
Rent	15
Light—Heat	16
Sundries—Office Expenses	17
	18
	19
General.	
Traveling Expenses	20
Hotel—Meals—Overtime	21
Livery	22
Advertising	23
Insurance	24
Discount—Exchange	25
Freight—Express (Sundry)	26
Repairs—Office, etc.	27
Sundries (General)	28
Legal Expenses	29
License Taxes	30
Charity	31

EXPENSE UNITS.

"The expense or cost of all labor, supplies, etc., connected with the contract is classified by the units 0 to 9 as follows:

0—ACCOUNT. The account or charge number to designate each department. Always to be used in transferring balance from one department into another.

1—FOREMAN. Wages of foreman.

2—LABOR. Wages of laborers.

3—TEAMS. Cost of teams, a monthly transfer charge. The amount or rate per horse is arrived at by taking the total cost of Stable Department No. 40 and dividing it proportionately on basis of 'horse hours' worked. Wages of teamsters in each department where work is performed.

4—SUNDRIES. Sundry items of expense that are not specially covered by any of the other units.

5—REPAIRS. The cost of all the labor and material used in making repairs in the departments. This will consist, principally, of the monthly charges—transfers from the 'Repair Shop' Account No. 50.

6—SUPPLIES. All supplies used in the department. Items of supplies that are solely used in one department, and will be entirely used during the month in which they are received, may be charged direct to this unit in the proper department; but if the quantity is to be divided into two or more departments, or is not all used in one month, it should be charged to Supplies Account No. 370, and then have the charges brought over from the daily summary of the requisitions for the article as it is delivered and used.

7—FUEL-POWDER. Cost of fuel, powder, or feed, according to the item and department in which it is used. The cost of the feed for the stable is charged to this unit No. 47.

The cost of explosives—dynamite, powder, fuse, and caps—for excavating, etc., as No. 257, 407, 427, etc. The cost of coal, etc., for fuel for the several departments, as No. 57, 67, 77, etc.

These charges will come from supplies account No. 370 as reported on requisitions.

8—MATERIAL. This unit is strictly for 'Construction Material' used on the contract, and for which the company will receive payment through the engineer's estimates, and must not be confused with ordinary 'Repair Supplies,' which are expense items. In case of emergency, where it becomes absolutely necessary to use any construction material for repair work (an expense), the item must be issued on a requisition, and transferred or charged to the proper repair item in the proper department, giving credit to Material Account for the actual cost.

All bills for construction material must pass through the 'Material Account,' and be charged out only when used or put in place, being credited to No. 380.

9—RESERVE. This unit is for the monthly charge to the several departments, for the monthly proportion of plant rental, plant depreciation, development, and the general expense of the Chicago office. The reserve is only divided to departments Nos. 49 to 200, and Nos. 359 and 369.

DISTRIBUTION SCHEDULE.

	0	1	2	3	4	5	6	7	8	9
Department Accounts.	Acct. No.	Foreman.	Labor.	Team.	Sundries.	Repairs.	Supplies.	Fuel Powder.	Material.	Reserve.
OPERATING.										
Stables (horses)	40	41	42	43	44	45	46	47	...	49
Repair Shops—Tools	50	51	52	53	54	55	56	57	...	59
Water Department	60	61	62	63	64	65	66	67	...	69
Power	70	71	72	73	74	75	76	77	...	79
Electric Light	80	81	82	83	84	85	86	87	...	89
Boats	90	91	92	93	94	95	96	97	...	99
Locomotives	100	101	102	103	104	105	106	107	...	109
Cars	110	111	112	113	114	115	116	...	...	119
Track	120	121	122	123	124	125	126	...	...	129
Excavators	130	131	132	133	134	135	136	137	...	139
Pile Drivers	140	141	142	143	144	145	146	147	...	149
Drills—Steam, Air	150	151	152	153	154	155	156	...	...	159
Machinery—Derricks	160	161	162	163	164	165	166	167	...	169
Plows—Implements	170	171	172	173	174	175	176	...	...	179
Wagons—Scrapers	180	181	182	183	184	185	186	...	...	189
Pit Tools (Picks, etc.)	190	191	192	193	194	195	196	...	...	199
Contract—General	200	201	202	203	204	205	206	207	...	209
Blasting	250	251	252	253	254	255	256	257	...	...
Loading—Mucking	260	261	262	263	264	265	266	...	...	...
Hauling	270	271	272	273	274	275	276	...	...	...
Dump	280	281	282	283	284	285	286	...	...	...
Trestle—Timbering	290	291	292	293	294	295	296	...	...	...
Commissary	350	351	352	353	354	355	356	357	...	359
Hotel—Camp	360	361	362	363	364	365	366	367	...	369
Supplies	370	...	372	373	374	...	...	...	...	...
Construction Material	380	...	382	383	384	...	...	...	...	...
GRADING.										
Clearing	400	401	402	403	404	405	406	407	...	...
Close Cutting	410	411	412	413	414	415	416	...	...	...
Grubbing	420	421	422	423	424	425	426	427	...	...
Earth Excavating	430	431	432	433	434	435	436	437	...	...
Hard Pan	440	441	442	443	444	445	446	447	...	...
Cement Gravel	450	451	452	453	454	455	456	457	...	...
Solid Rock	460	461	462	463	464	465	466	467	...	...
Loose Rock	470	471	472	473	474	475	476	477	...	...
CULVERT—TRESTLE.										
Iron Pipe	520	521	522	523	524	525	526	...	528	...
Vitrified Pipe	530	531	532	533	534	535	536	...	538	...
Timber	540	541	542	543	544	545	546	...	548	...
Piles—Trestles	550	551	552	553	554	555	556	...	558	...

These schedules are accompanied by concise directions as to what items and details pertain to each distribution number and how the accounts are to be posted and reported. The "Reserve Depreciation" is arbitrarily fixed for each item of plant, and varies from 0.5 per cent. per month for tools and real estate to 4.0 per cent. for marine equipment. These percentages have been fixed with good judgment, except

DISTRIBUTION SCHEDULE.

Department Accounts.	0 Acct. No.	1 Foreman.	2 Labor.	3 Team.	4 Sundries.	5 Repairs.	6 Supplies.	7 Fuel Powder.	8 Material.	9 Reserve.
FOUNDATION.										
Wet Earth Excavating	580	581	582	583	584	585	586	...	...	...
Dry " "	590	591	592	593	594	595	596	...	...	...
Wet Rock "	600	601	602	603	604	605	606	607	...	...
Dry " "	610	611	612	613	614	615	616	617	...	...
MASONRY.										
Bridge, 1st Class.	640	641	642	643	644	...	646	...	648	...
" 2nd "	650	651	652	653	654	...	656	...	658	...
Masonry, 3rd "	660	661	662	663	664	...	666	...	668	...
" (Mortar) 4th "	670	671	672	673	674	...	676	...	678	...
" (Dry) 4th "	680	681	682	683	684	...	686	...	688	...
" (Arch) 1st "	690	691	692	693	694	...	696	...	698	...
" (") 2nd "	700	701	702	703	704	...	706	...	708	...
Paving	710	711	712	713	714	...	716	...	718	...
Rip Rap	720	721	722	723	724	...	726	...	728	...
Concrete	730	731	732	733	734	...	736	...	738	...
Rubble—Cement	740	741	742	743	744	...	746	...	748	...
" —Dry	750	751	752	753	754	...	756	...	758	...
Brick	760	761	762	763	764	...	766	...	768	...
TUNNEL.										
Excavating Total	800	801	802	803	804	805	806	807	808	809
Masonry, Sidewall, 1st Cl.	810	811	812	813	814	...	816	...	818	...
Masonry, Sidewall, 2nd Cl.	820	821	822	823	824	...	826	...	828	...
Masonry, Sidewall, 3rd Cl.	830	831	832	833	834	...	836	...	838	...
Masonry, Sidewall, 4th Cl.	840	841	842	843	844	...	846	...	848	...
" Arch 1st, "	850	851	852	853	854	...	856	...	858	...
" " 2nd, "	860	861	862	863	864	...	866	...	868	...
" Brick—Sidewall.	870	871	872	873	874	...	876	...	878	...
" " Arch	880	881	882	883	884	...	886	...	888	...
" Concrete — Sidewall	890	891	892	893	894	...	896	...	898	...
" Concrete—Arch.	900	901	902	903	904	...	906	...	908	...
Dry Packing	910	911	912	913	914	...	916	...	918	...
Timber Lining	920	921	922	923	924	...	926	...	928	...
Iron Work	930	931	932	933	934	...	936	...	938	...
MCCOOK SHOPS.										
Blacksmith	950	951	952	953	954	955	956	957	958	959
Machine	960	961	962	963	964	965	966	967	968	969
Wood	970	971	972	973	974	975	976	977	978	979
Pattern	980	981	982	983	984	985	986	987	988	989
Yard	990	991	992	993	994	995	996	997	998	999

that 0.5 per cent. seems small for picks, shovels, and small tools. A "Reserve Rental" for plant is also charged to each department and contract.

It will be noted that there are nine expense units or sub-divisions of department accounts. Should a larger number be required, they can be provided by giving each department account a number divisible by 20, beginning with 40; or, as will be better in some cases, even-hundred numbers. The latter arrangement will run most of the distribution numbers into four figures, but with mechanical and electrical accounting machines, this is no disadvantage. It is rather to be preferred, if nine expense units do not give sufficient detail, and for masonry, concrete, and structural work generally, a somewhat greater sub-division appears to be desirable. Some numbers are left blank to provide for special distribution accounts when required.

In organizing the force of time keepers and clerks on a large contract there should be at least one man on each division who has sufficient knowledge of engineering to make measurements and calculate quantities. One of the first duties of these men should be to make a record of the original cross sections, from the center and slope stakes (or by measurements), unless they can be obtained from the engineer. This work should be done before ground is broken at the points where grading is to be commenced, and should always be kept up ahead of the graders.

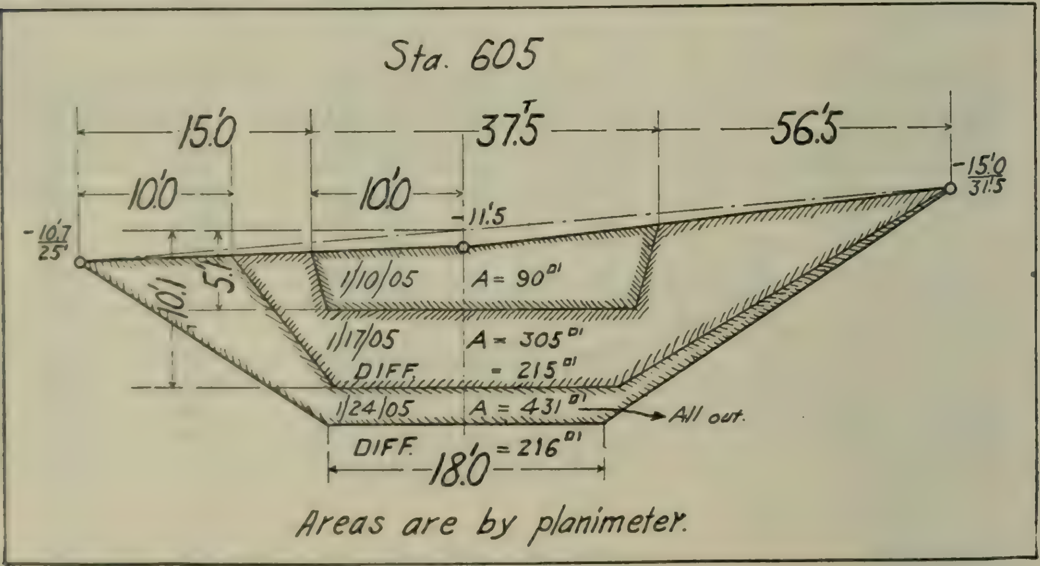


FIG. I. EXAMPLE OF PROGRESS CROSS SECTION, INDICATING HOW MEASUREMENTS MAY BE TAKEN BY APPROXIMATE METHOD.

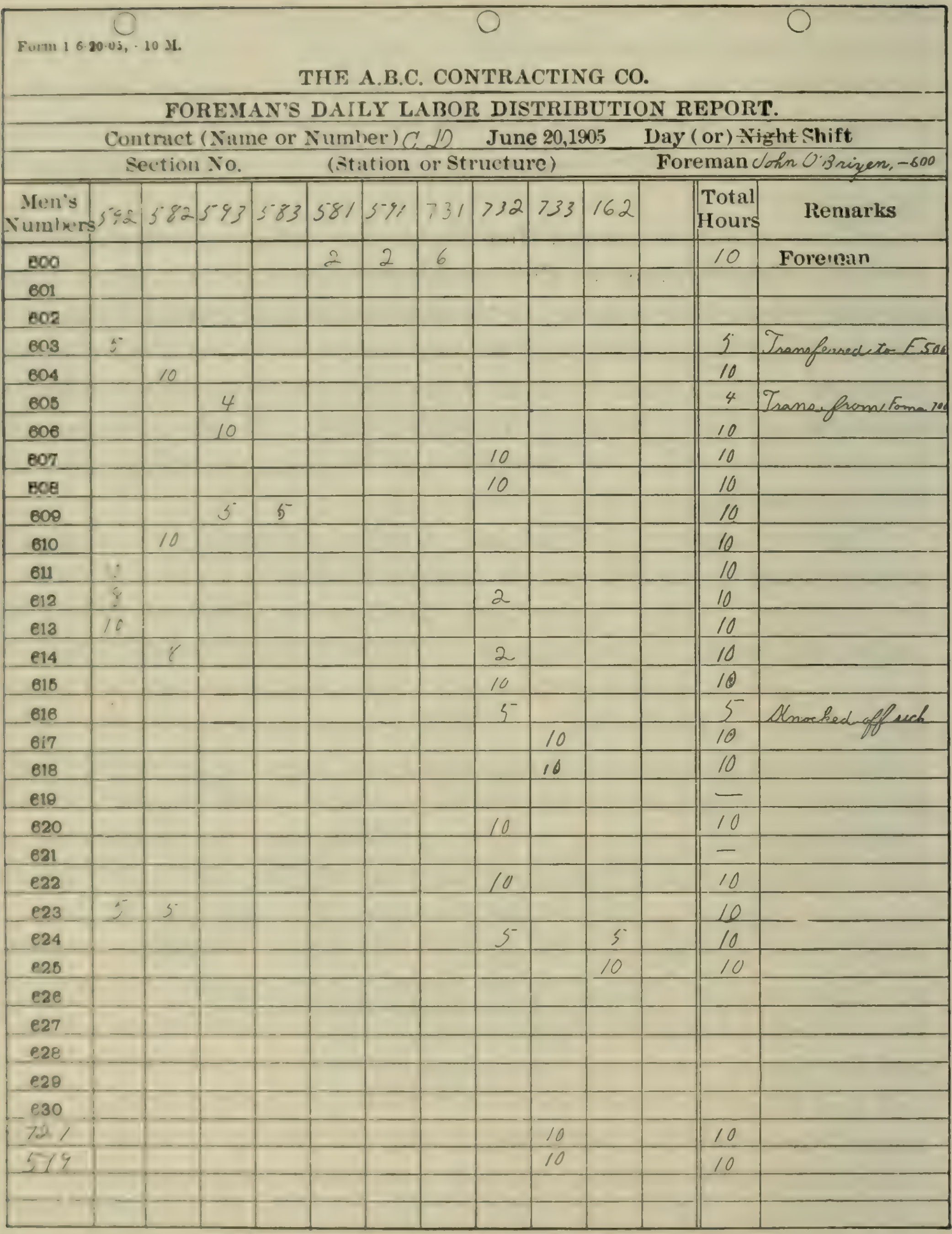
At the end of each month, or at the close of each pay-roll period, or at any time desired, two men can make approximate measurements from which quantities can be computed with sufficient accuracy for the purpose of determining unit costs or for checking engineers' estimates. This work can be done with great rapidity if properly laid out and arranged. The cross sections should be plotted on cross-section paper, and the progress notes recorded on the same. The areas can then be read off by planimeter, and, from these, one setting of a slide rule gives the cubic yards.

On blue prints of the working drawings of masonry and other structures, the same men should note the actual elevations of foundations and draw lines denoting the progress of the work at corresponding dates.

All the quantities should then be entered on an estimate sheet, in columns corresponding to their respective department-account numbers, and on the line assigned to the section, station, structure, or foreman to which they belong. The summation of the vertical columns gives the total of each kind, and the arrangement is such that the quantities belonging to any part of the work or to any foreman can be readily taken off. The costs, divided by these quantities, give the unit costs sought.

The time keepers will list and number all employees, assigning to each division, department, or foreman's gang a series of consecutive numbers. While consecutive numbers by divisions cannot be maintained unbroken, on account of unavoidable transfers, it will be found to greatly facilitate the work of summarizing results to have the majority of the workmen in each group numbered in one series. The time may be recorded in short-leaf time books or in special books, in which the name (correctly spelled), as well as the number of each man is distinctly written. It is not probable that the distribution of time can be successfully taken by the time keepers, unless they should record it at the dictation of the foreman. For this reason, foremen should be furnished with sheets for daily labor distribution reports, see Figure 2. On these sheets the foreman will fill in the account numbers at the head of each column, according to the distribution schedule, and the time of each man, including his own, on each account. He will also fill in the total time of each man and in the column of "Remarks" the reason for short time, giving the number or name of other foremen to or from whom transfers were made. Any unusual or accidental incidents which affect the progress or cost of the work should also be noted under "Remarks."

The Daily Labor Distribution Report sheets should be returned to the office at the close of each working day, where they will be transcribed to the punched record cards of the Hollerith electrical tabulating machine. Figure 3 is the fac-simile of such a card designed for analyzing a shop pay roll, and used by the bridge and construction department of the Pennsylvania Steel Company. With a few changes, such as inserting letters in four columns for the designation of con-



Form 1 6-20-05, - 10 M.

THE A.B.C. CONTRACTING CO.

FOREMAN'S DAILY LABOR DISTRIBUTION REPORT.

Contract (Name or Number) C. D. June 20,1905 Day (or) ~~Night~~ Shift

Section No. (Station or Structure) Foreman John O'Brizen, -600

Men's Numbers	592	582	593	583	581	591	731	732	733	162		Total Hours	Remarks
600					2	2	6					10	Foreman
601													
602													
603	5											5	Transferred to F 50
604		10										10	
605			4									4	Trans. from Fore. 7
606			10									10	
607								10				10	
608								10				10	
609			5	5								10	
610		10										10	
611	[illegible]											10	
612	8							2				10	
613	10											10	
614		8						2				10	
615								10				10	
616								5				5	Knocked off sick
617									10			10	
618									10			10	
619												—	
620								10				10	
621												—	
622								10				10	
623	5	5										10	
624								5		5		10	
625										10		10	
626													
627													
628													
629													
630													
721									10			10	
519									10			10	

FIG. 2. SHEET FOR LABOR DISTRIBUTION REPORT.

tract or department, another column for the designation of the foreman's number, the addition of the letters "H" and "B" to designate heading or bench in tunneling, the omission of columns for "Number of Pieces" and "Class" and the substitution of "Force Account" for "Extra"—we would have a suitable card. The cards, however, will vary more or less as the character of the work changes.

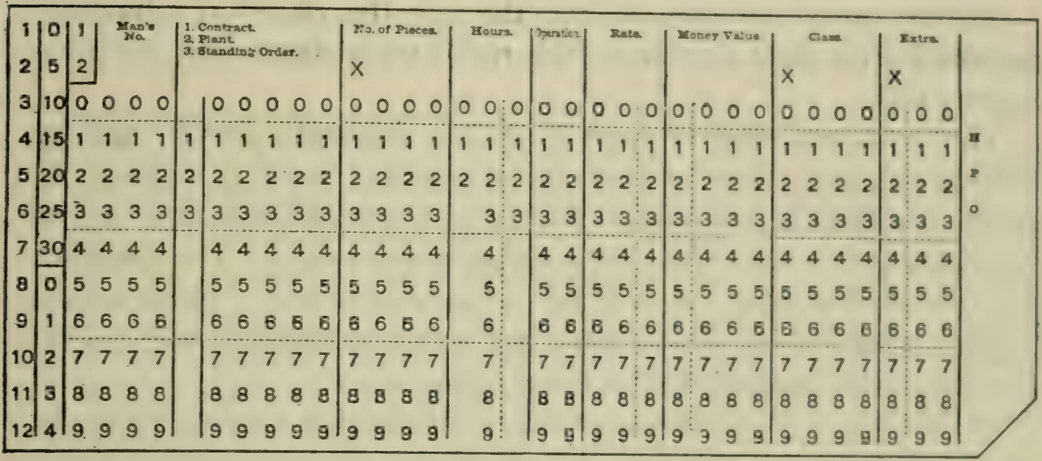


FIG. 3. EXAMPLE OF CARD DESIGNED FOR ANALYZING A SHOP PAY-ROLL BY AID OF THE TABULATING MACHINE.

The date or day columns are punched on a "gang punch" which punches all the holes required in ten or fifteen cards at one operation. The man's number, account number, foreman's number, hours and rate are then punched on a key punch. A separate card is punched for each man and for each account number on which he has worked. All of this work is rapidly performed by boys who receive from $3.00 to $5.00 per week.

When the rate and hours have been punched in the cards, they may be put into an automatic sorting machine, which will separate out all cards having the same time (hours) and rate of pay. The amounts are then carried out by tables of wages or computed with the "Brunsviga" calculating machine, and recorded on the cards with the gang punch or key punch as required. Figure 4 is the fac-simile of a punched card.

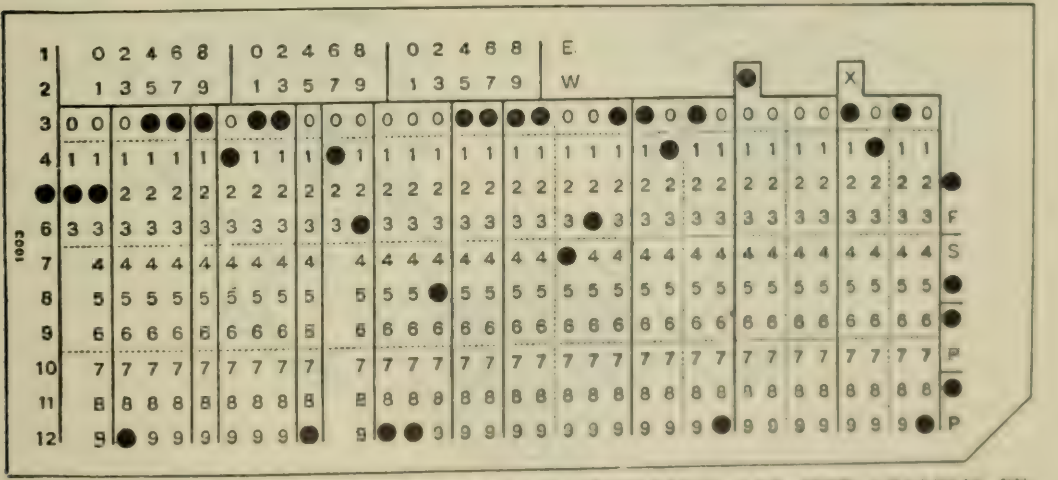


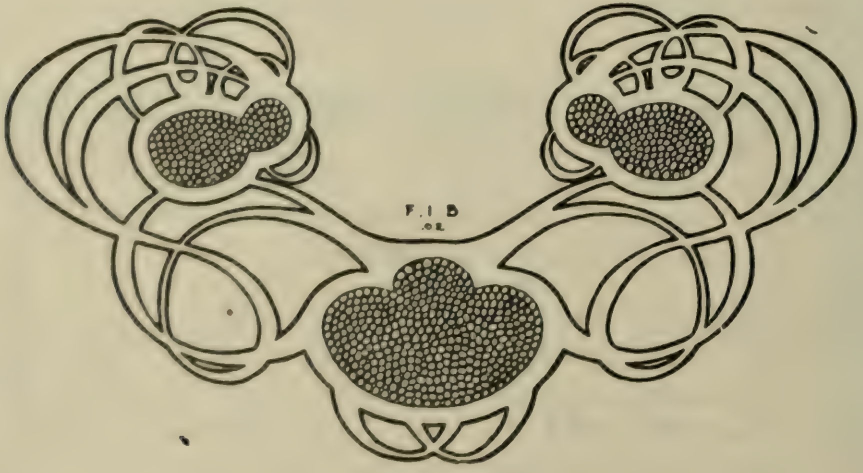
FIG. 4. SHOWING A CARD AS PUNCHED FOR TABULATION AND COST ANALYSIS BY THE HOLLERITH MACHINE.

All the cards can then be run through the electrical tabulating machine for the total amount, which result must check with the time-keeper's roll.

The cards are then segregated by the automatic sorter, first by account numbers, then by foreman's numbers, and, if desired, by account numbers and foreman's numbers, or by job, structure, or station numbers when the latter are included in the record. The tabulator gives the total amount for each lot of cards as sorted. These results are all entered on manifold sheets, and copies are sent to the general manager, to the auditor, and to the superintendent.

For the purpose of carrying out and distributing General Expense, (Accounts 1 to 39 inclusive), and all similar accounts, I have found a Brunsviga calculating machine a very great relief and time saver. It will multiply and divide, pro-rate and compute interest, quickly and accurately. It is simple, and can be operated with less liability to error than any other machine with which I have worked, on account of the facility it affords for checking the work and correcting an error without going back over the entire computation. It will carry a long series of computations and give both the partial and final results. It can also be used for addition and subtraction, but for addition only it is not quite as quick as the adding machine made by the Mechanical Accountant Company.

An up-to-date accounting department of a large company should be supplied with all the best facilities if it is expected to turn out good work economically. These machines both save time of valuable men, and to some extent permit certain parts of the work to be performed by cheaper labor.



A COMBINED BONUS AND PREMIUM SYSTEM.

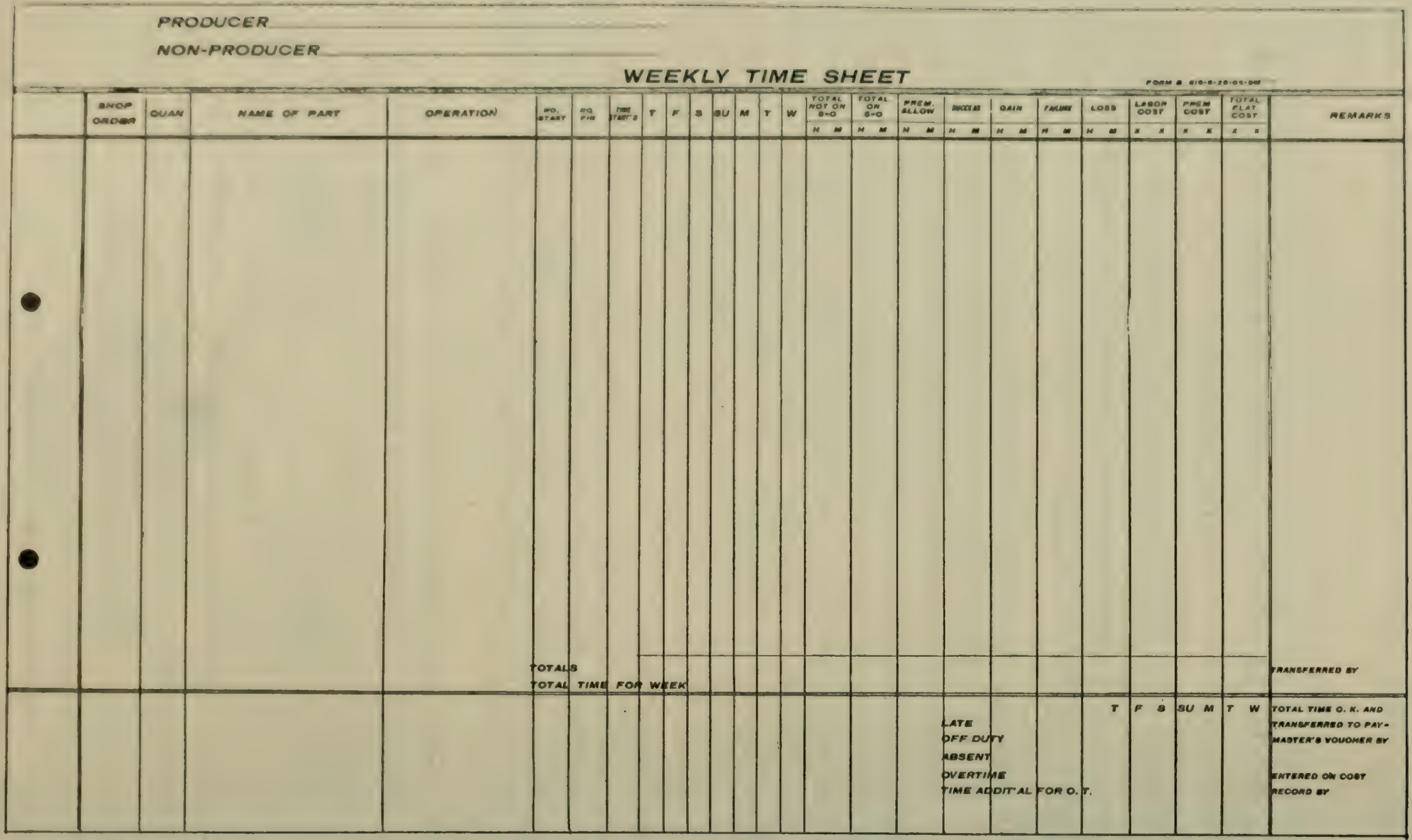
By Hugo Diemer.

Mr. Diemer's article has the great interest which attaches to every well considered effort to avert labor troubles and stimulate the workman's productivity by the opportunities and rewards of a wisely planned wage system. It has the vital importance also which belongs to the practical record of actual experience. It not only describes a thing worth doing, but explains how to do it.—The Editors.

THE change from hourly or day rate to a merit system of wages is a step which needs to be well planned and well executed. Otherwise the benefits desired may be delayed or not at all realized. This change is being taken or likely to be taken by many establishments; hence interest will attach to the experiences and methods of an engine and boiler works in adopting a combined premium and bonus system. The system in the form into which it has now developed is original in several ways. The method of compensation for successful effort is different from any enumerated in the various tables, charts, or curves prepared and published for comparison of various wage systems.

The company in question is employing at present some eight-hundred men, although in busy seasons they have had as many as two-thousand men at work in the manufacture of slide-valve, four-valve, and Corliss engines, and fire-tube, marine, locomotive, and water-tube boilers.

The establishment has long been recognized as a stronghold of trades unionism. The management has always accorded fullest recognition to trades unions. Something over a year ago the management proposed to the representatives of the machinists' union the introduction of the 50-per-cent. gain-sharing system of the kind which Mr. Taylor has christened the "Towne-Halsey" plan. The union would not accept this system, but after considerable negotiation agreed to the following plan:—The company was to fix what it considered a fair or "standard" time for each operation. For successful accomplishment of the task within this time, each man was to receive an increase of 20 per cent. over his hourly rate. For agreeing to work under the "standard-operation" plan, any man was to receive a 10-per-cent. increase on his hourly rate for all time spent on tasks on



PRODUCER

NON-PRODUCER

WEEKLY TIME SHEET

FORM B [illegible]

SHOP ORDER	QUAN	NAME OF PART	OPERATION	NO. START	NO. FIN	TIME START'S	T	F	S	SU	M	T	W	TOTAL NOT ON S-O		TOTAL ON S-O		PREM. ALLOW		SUCCESS		GAIN		FAILURE		LOSS		LABOR COST		PREM COST		TOTAL FLAT COST		REMARKS
														H	M	H	M	H	M	H	M	H	M	H	M	H	M	$	¢	$	¢	$	¢	
				TOTALS																														TRANSFERRED BY
				TOTAL TIME FOR WEEK																														

LATE
OFF DUTY
ABSENT
OVERTIME
TIME ADDIT'AL FOR O. T.

T F S SU M T W

TOTAL TIME O. K. AND TRANSFERRED TO PAYMASTER'S VOUCHER BY

ENTERED ON COST RECORD BY

FIG. I. WEEKLY TIME SHEET. ORIGINAL IS 15½ BY 9½ INCHES.

which a standard time limit was set, whether the task was accomplished within the time or not, this being called "the 10 per cent. for effort." For "success," 10 per cent. more was added, making the 20 per cent. all-told. Inasmuch as the company was paying a considerable increase for accomplishment of work within the standard times, these standards had to be a great deal lower than the past performance, which made it harder to start the system than the gain-sharing system, in which the standard is usually not lower by a great deal than past records. It was thought that the 10 per cent. for effort would be the entering wedge, however. The standards, in the case of the machine shop, were figured by the general foreman, based on calculations of feeds and such additions as he thought proper for chucking and getting ready. The majority were fixed very close to the best performance of a skilled man under favorable conditions, this being in accord with Mr. Taylor's and Mr. Gantt's principles. After about a year's trial, it was found that the number of men receiving the 20 per cent. for "success" did not approach the company's anticipations. Visits were made by one of the company's officers to shops using the Towne-Halsey system, and a superintendent of one of these shops was engaged to complete the establishment of standards on such operations as were still without the "stint," and to act in an advisory capacity in giving such assistance and advice to men and foreman with regard to methods of doing the work as would result in an increasing number of men accomplishing "success" under the system.

It was decided to abandon the time-keeping system which had been in vogue, under which each man posted his own time, presumably checked by the foreman. The management adopted the time-taker plan, the form of time sheet being shown in Figure 1. The arguments advanced for this method of time keeping were that experienced time keepers could do this work far more quickly than workingmen, and hence the time saved out of workingmen's time would be more than enough to pay the time-takers' wages. An important phase of the question—that of doctoring the time in favor of the workmen—was not dwelt on at length, since the management had great faith in the integrity of all its employees and the argument of economy was in itself sufficient.

As the "time-taker" method of securing data regarding time required to do work may not be familiar to all, it may be well to explain it briefly. A young man of mature years and judgment, and preferably with machine-shop experience, spends his whole time in going from man to man in the department to which he is assigned, entering on the time sheet for each workman every change of operation. There is a sheet for each workman, and the sheets for any one department are kept in a metal binder, making it easy for the time taker to make entries while standing.

The "Instructions to Time-Takers" given below will explain fully some details of the system. These instructions were mimeographed and a copy given each time taker and also to each foreman:—

Instructions to Time-Takers.

"1. Do not take up more of workman's time than is actually required to get the necessary information.

"2. If workman is engaged in handling or setting up heavy work in his machine, do not call him away from same. See him at some later time.

"3. The following questions should suffice to secure all information needed for time-taking:

"When did you start this job?

"How many pieces did you finish on the previous job?

"Where is the tag for your present job?

"Name of operation on job engaged on.

"4. Always bear in mind that the starting time on one job is the stopping time of the previous job. Make no allowance for setting up machine unless time for setting up is allowed and authorized by foreman, with general foreman's approval.

"5. In cases where workmen have no tag for job worked on, notify department foreman, and he will provide workman with same.

"6. Instruct workman to hang tag for job on which he is working in some convenient place for you to see same. In passing about, look at both his tag and his work so as to make sure that he has not changed jobs. Familiarize yourself with the work going through the department to which you are assigned, as that is a great aid to accurate time-taking.

"7. The following information must be correctly given on time sheet, viz.: shop-order number, amount of pieces in lot, name of part, name of operation or operations, premium allowance (where specified on tag only), number of pieces started, number of pieces finished, time started, time finished, and allowances if any. Insist on men reporting correctly the number of pieces finished whenever a break in lot occurs. You will make entries after each job in the proper column headed 'Total not on

Standard Operation,' 'Total on Standard Operation,' 'Success,' 'Gain,' 'Failure' and 'Loss.' Enter these items as soon as the available time entries have been made. Do not make any entries in columns headed 'Labor Cost,' 'Premium Cost' and 'Total Flat Cost,' nor in pay-roll department's items at lower right-hand side of sheet.

"8. You can be of some aid to the foreman in your department by informing him in advance that a man is likely to be out of a job at a certain time. It will be well to notify foreman about thirty minutes previous to the time a man will finish the job he is working on. This will give him a chance to look up the man's next job. When men are overrunning standard time you will notify Mr. —— (this being the consultant referred to), by telephone or messenger.

"9. All time for jobs on which there are no tags will be covered by a list of standing orders. You must govern yourself according to this list in charging time. Be sure to specify fully the nature of any such work. When there is any doubt as to what standing-order number to charge this work to, consult head time-taker.

"10. Make no allowance on account of bad or hard castings or on account of break-downs or other unavoidable causes, unless same are verified by foreman. Foreman must give you an allowance ticket covering the actual time lost. Write time allowed in 'Remarks Column' of time sheet, and turn allowance tickets for the day over to head time-taker, in the evening. Had time-taker will have them endorsed by general foreman and then file them.

"11. Familiarize yourself thoroughly with the Conditions and Rulings in Connection with the Standard-Operation Plan."

The "Conditions and Rulings in Connection with Standard Operation Plan" explain the wage system quite fully, with the exception that no mention is made of any allowances for hard castings, nor of the 10 per cent. allowed for effort. In the case of hard castings, the omission was made because it was thought not best to call men's attention needlessly to this possible source of allowances. In the case of the 10 per cent. for effort, mention of this feature was omitted because the company has taken the stand that this allowance is to be made only on such work as has not yet been accomplished in the standard time as fixed, the intention being to do away with it altogether in time. The text of the rulings and conditions governing the system is given in its entirety on the following pages. It will be noted that they are full and explicit, and leave no opportunities for misunderstanding of the system:—

Rulings and Conditions Governing Work under "Standard-Operation" Plan.

In order that all employees may be thoroughly familiar with the conditions and rulings in connection with the Standard-Operation Plan, the following outline has been prepared:—

1. The 20-Per-Cent Increase for Success.

"For all jobs successfully completed within the standard time, the company will pay in addition to the regular hourly wages at which a man is employed, an increase of 20 per cent over his regular hourly rate. For instance, a man employed at 20 cents an hour will be paid 24 cents an hour for all work successfully done under standard-operation plan.

2. The 50-Per-Cent Bonus for Gain.

"For all jobs successfully completed within less than the standard time, the company will pay in addition to the 20-per-cent increase, as explained in section 1, a gain-sharing bonus of 50 per cent of the man's base rate for all time gained. For instance, if a man employed at 20 cents an hour brings out successfully in 10 hours a job on which the standard-operation time is fixed at 12 hours, he receives 50 per cent of the saving, or 20 cents extra pay, in addition to receiving 24 cents an hour for all work successfully done under standard-operation plan. All those that desire to take advantage of the 50-per-cent or gain-sharing feature of the plan can do so by notification to their foreman.

3. Quality of Work.

"Work must be completed to entire satisfaction of foreman and inspector. Time is counted for good work only. For instance, if a man has ten pieces to do and spoils one, the time is counted as applying on nine pieces finished.

4. Extra Work on Account of Bad Castings.

"In case a casting shows flaws after machine work is begun, foreman's attention must be called to same at once. If casting is then thrown out, foreman will determine allowance for time spent on same, and will enter allowance on a credit slip, which he gives workman, who will hand credit slip to time taker at his next round. Time taker will enter credit in "Remarks" column of time sheet.

5. Extra Time on Account of Breakdowns or Other Unavoidable Causes.

"Foreman's attention must be called to such time at once, and he will determine allowance if any, and hand workman credit slip. Workman will hand time taker credit slip at his next round, and time taker will enter credit, if any, same to be verified by foreman. Workmen are not permitted to work on machinery repairs excepting those regularly engaged on this work.

6. Several Men Working on Same Standard Operation.

"Where standard-time work is of such nature that it requires to be participated in by a group of several men, each man's share of the bonus, if any, will be in proportion to the number of hours he has put in the job.

7. Time Within Which Work Must Be Done.

"Standard times as fixed constitute the limits allowed, and work must be done within these time limits if credit is desired for the bonus for success.

8. Unfinished Work.

"Any man working on a standard-operation job and not finishing same, will be paid bonus, if any, on only the actual number of pieces in the lot on which complete operation has been performed. If operation has been partly completed and the work is finished by someone else, workman starting the job forfeits his bonus, and workman finishing the job will be paid a bonus on same only if job is finished within a reasonable time limit. It will be left to the foreman to determine if this has been done.

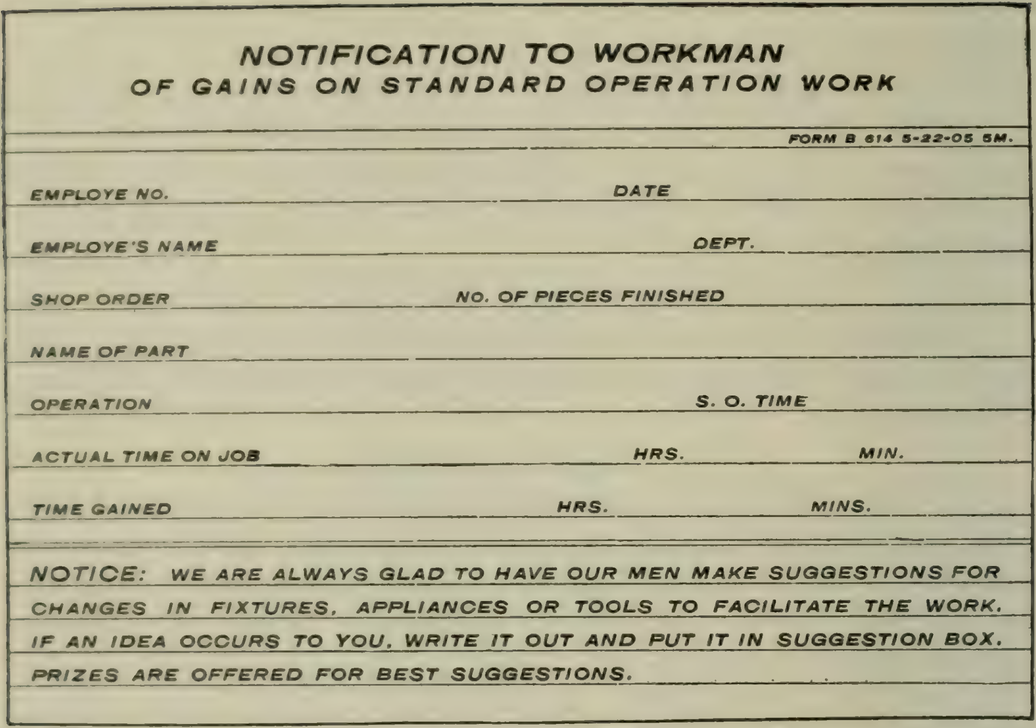
9. Difficulties Preventing Success.

"It is the company's desire to take every step possible to remove any obstacles standing in the way of accomplishing any job in the standard time. They wish and expect the men to make money out of the standard-operation plan. They also wish men and foremen to feel free to make suggestions for improvements which may remove any difficulties in the way of making the stints regularly. Suggestions will be acted upon as promptly as conditions will permit.

10. Permanence of Standard Time.

"Standard time once fixed will not be changed excepting on account of changes in design, introduction of new tools, or entirely different methods of doing the work.

Figure 2 is a daily "Notification to Workman." The daily service in connection with notices to workmen of losses or gains over standard-operation time proved advantageous in many ways. It is realized of course that a retrospective investigation after work is finished and hauled away is always unsatisfactory. There are always numerous plausible causes assigned for the over-running of time, if it is seen that other excuses are wanted than that the time is too low. These slips do not constitute the only effort at time reduction. The



NOTIFICATION TO WORKMAN
OF GAINS ON STANDARD OPERATION WORK

FORM B 614 5-22-05 5M.

EMPLOYE NO. DATE

EMPLOYE'S NAME DEPT.

SHOP ORDER NO. OF PIECES FINISHED

NAME OF PART

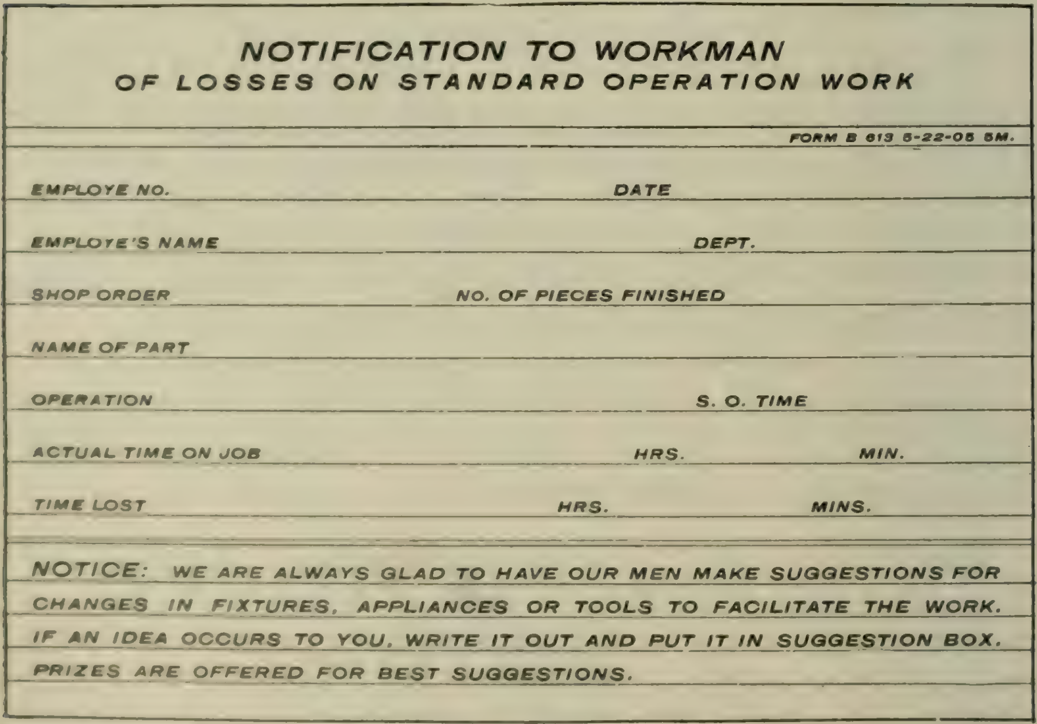
OPERATION S. O. TIME

ACTUAL TIME ON JOB HRS. MIN.

TIME GAINED HRS. MINS.

NOTICE: WE ARE ALWAYS GLAD TO HAVE OUR MEN MAKE SUGGESTIONS FOR CHANGES IN FIXTURES, APPLIANCES OR TOOLS TO FACILITATE THE WORK. IF AN IDEA OCCURS TO YOU, WRITE IT OUT AND PUT IT IN SUGGESTION BOX. PRIZES ARE OFFERED FOR BEST SUGGESTIONS.

FIG. 2. NOTIFICATION TO WORKMEN OF TIME GAINED.
Original is on pink paper, 6 by 4 in.



NOTIFICATION TO WORKMAN
OF LOSSES ON STANDARD OPERATION WORK

FORM B 613 5-22-05 5M.

EMPLOYE NO. DATE

EMPLOYE'S NAME DEPT.

SHOP ORDER NO. OF PIECES FINISHED

NAME OF PART

OPERATION S. O. TIME

ACTUAL TIME ON JOB HRS. MIN.

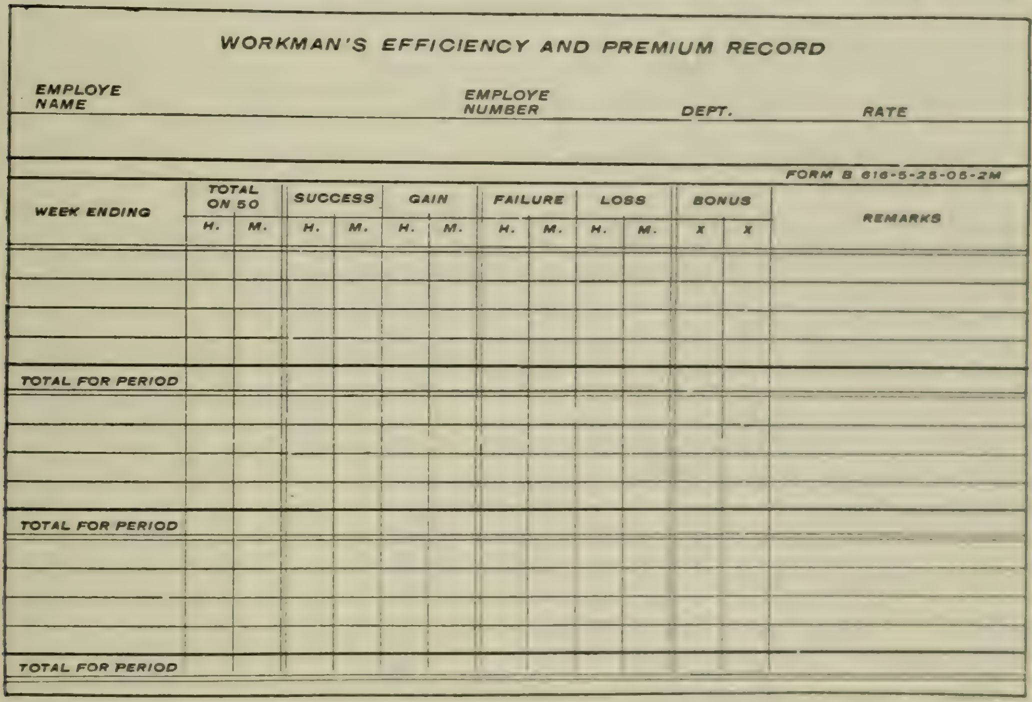
TIME LOST HRS. MINS.

NOTICE: WE ARE ALWAYS GLAD TO HAVE OUR MEN MAKE SUGGESTIONS FOR CHANGES IN FIXTURES, APPLIANCES OR TOOLS TO FACILITATE THE WORK. IF AN IDEA OCCURS TO YOU, WRITE IT OUT AND PUT IT IN SUGGESTION BOX. PRIZES ARE OFFERED FOR BEST SUGGESTIONS.

FIG. 2. NOTIFICATION TO WORKMEN OF TIME LOST.
Original is on blue paper, 6 by 4 in. These slips are used as a means of keeping the workman informed, day by day, of his success or failure in reaching "standard-operation" time, and thus avoiding the uncertainty and dissatisfaction so often attendant on after-investigations.

time-taker's telephone or memorandum messages that men are falling behind, which are sent to the engineer in charge of rate fixing, afford the best opportunities for investigation while the work is in progress.

It is only natural that in a strongly unionized shop, where the standard times are often as low as one-third the old time of doing work, the men require to be closely watched, since even after satisfactory demonstration that work can be done properly with certain speeds and feeds, the men will revert back again to light cuts, and slow speeds, and every other resource of delay that they can conjure up. The prime factor in time reduction must of course be the personal observation of the work, resulting in proper speeds and feeds being used and in seeing that loose belts, lame machines, etc., are attended to, proper jigs provided, etc. However, the running records of performance under the system form an important phase of the work, not only being the proof of the pudding, but helping materially in attainment of results. Thus the notification slips to workmen, which are given first to general foreman, then to department foreman, and then to men, keep all of these in close touch with the system. The result is that the causes of over-running are traced up and remedies applied, where otherwise no attention would be paid. Another advantage is that the daily receipt by the workman of a "gain" ticket is an incentive



WORKMAN'S EFFICIENCY AND PREMIUM RECORD

EMPLOYE NAME
EMPLOYE NUMBER
DEPT.
RATE

FORM B 616-5-25-05-2M

WEEK ENDING	TOTAL ON 50		SUCCESS		GAIN		FAILURE		LOSS		BONUS		REMARKS
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	X	X	
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													

FIG. 3. WORKMAN'S EFFICIENCY AND PREMIUM RECORD.
Original is 6 by 4 in., white card, similarly ruled upon the back, as shown in Figure 5.

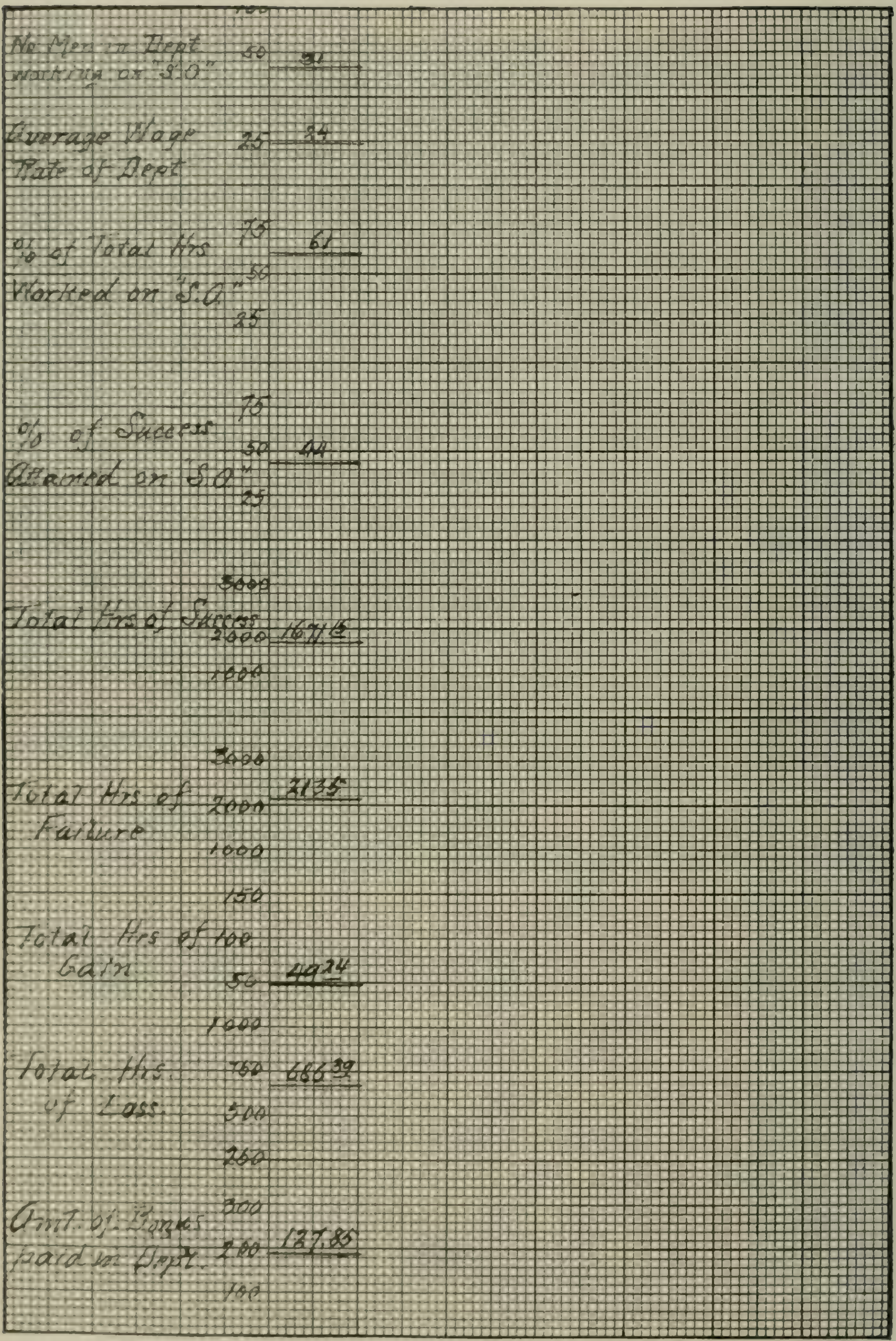
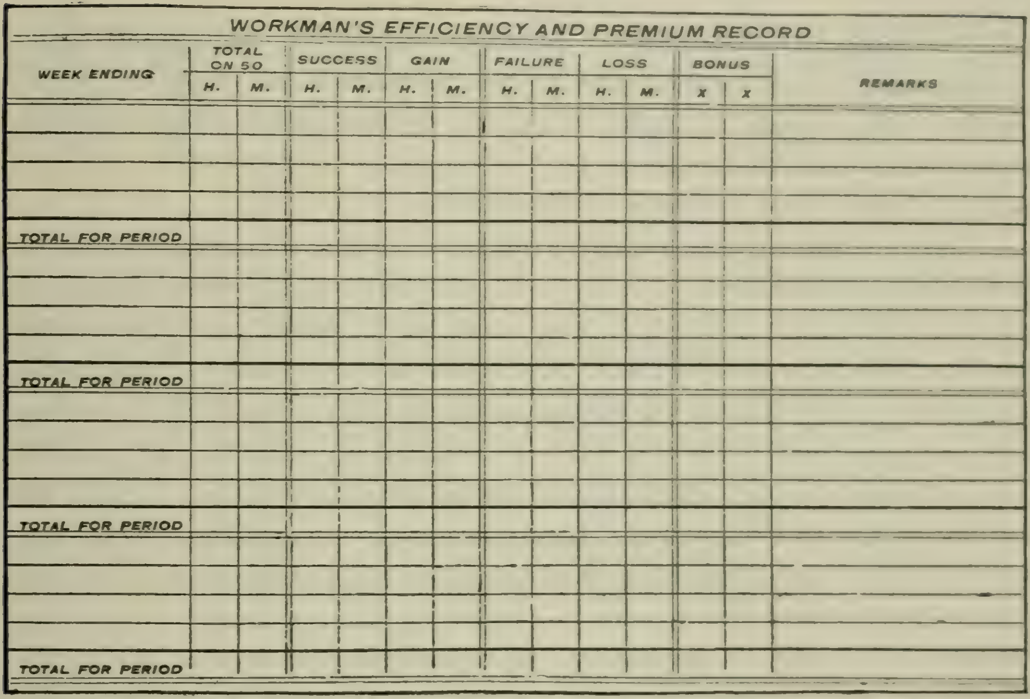


FIG. 4. CHART OF DEPARTMENTAL EFFICIENCY UNDER STANDARD-OPERATION PLAN. Department "C—1—2—4." The record shown is from May 14 to June 11. The original is a large sheet of cross-section paper, a separate sheet for each department.



WORKMAN'S EFFICIENCY AND PREMIUM RECORD

WEEK ENDING	TOTAL ON 50		SUCCESS		GAIN		FAILURE		LOSS		BONUS		REMARKS
	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	x	x	
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													
TOTAL FOR PERIOD													

FIG. 5. WORKMAN'S EFFICIENCY AND PREMIUM RECORD. BACK.

to him to strive for more such tickets. It will be seen that the notification slip contains full information, as well as some words of encouragement to the men.

Figure 3 is the Workman's Individual Efficiency Record. This card is filled at the time of calculating bonus money, (which is paid every four weeks), and the labor of posting on it is negligible, since the clerk figuring the premium pay-roll has to add up the totals for each period for each man at any rate, and instead of doing this on a scratch pad he enters the weekly totals of each man's record on this card. This card will greatly assist in according recognition to the good workmen and in weeding out the bad ones. The card is available in the machine-shop office at all times, which is an advantage, since the weekly time sheets are at certain periods in use by the payroll or cost-figuring clerks. The card is much easier to refer to than the weekly time sheets by themselves, as in looking up a workman's record for a considerable period of time, one would have to look through a number of weekly time books, whereas on the card it is neatly condensed for easy reference.

Figure 4 shows how departmental efficiency is charted by periods. The use of straight lines and avoidance of superposing of lines is intentional. These charts must show betterment in each department from period to period.

It will be noted that the endeavor has been to perfect the system of localizing troubles and of prompt notification regarding them. A diagnosis is made and a prescription furnished for the worst cases as they are brought to light, either by personal observation, by the time-takers' records as shown by "Notification to Workman," or by a message sent from foreman or time takers.

The question may be asked "Could not all this be accomplished by first-class foremanship?" It must be remembered however that high-grade foremen are rare—that they must be educated to higher standards and ideals as well as men. Moreover, the attention to production, and many petty details of foremanship, do not permit of the close attention to time reduction that is required in transitional periods. The systematic study involved in the scheme as outlined is also resulting in greater care and discrimination in hiring labor. It is interesting that the attitude of opposition which characterized the first year's work under the system is gradually passing away as the men become convinced of the fairness and possibility of attainment of the standards, and realize that they are not established by arbitrariness and a desire to oppose the workingmen, but by the absolute necessity of working every machine and every man at high efficiency in order to meet trade competition. Naturally, some errors are bound to be made in not allowing quite sufficient time for setting up, handling, and chucking and other conditions; but the willingness to investigate and correct any errors, coupled with absolute firmness if failure of accomplishment is not due to any errors in rate fixing, are resulting in a steady improvement.

EDITORIAL COMMENT

THE ENGINEERING MAGAZINE, in its issue for September and in the months immediately following, will have the privilege of presenting to the engineering profession and to the world the immensely valuable conclusions of Mr. John F. Wallace's year of study of the Panama Canal problem. The results of his admirable and exhaustive investigations on the Isthmus, directed through a corps of assistants in the field none of whom saw the entire plan and scope of the work—these will be brought together in their proper and intended relation by Mr. Wallace himself, and the deductions established by the same genius that organised and directed the preliminaries. Thus the full import of the knowledge gained for the United States during the first epoch of organized and able engineering direction, will be saved for present use and future guidance. Such information will be of the utmost value in assisting those who are interested in arriving at an accurate understanding of the canal problem, and of the methods to be followed in planning and constructing the great waterway.

Mr. Wallace's discussion, which was originally undertaken for THE ENGINEERING MAGAZINE with the approval of the Washington Administration as a very general statement of the physical aspects of the Canal problem, has thus broadened in scope and risen in dignity, and will appear as the original full synopsis of Mr. Wallace's professional study during his connection with the undertaking. In that record will be found his full justification—if any be needed—before his fellow engineers and the country at large. He will outline briefly the history of the project, the various plans and methods suggested for its execution, the field organisation and operations, the various factors entering into the problems of administration and control, and the engineering and technical features of the plan and construction. He holds steadfastly to the conviction that "at some time, in some way, and at some cost, the original idea will finally be realized," but he is not blind to "the price which is yet to be paid in lives, reputations, and money." He proposes to consider the subject "from the standpoint of a disinterested and unprejudiced investigator, without fear or favor of those who may be selfishly interested politically, financially, or otherwise, eliminating all motives of self interest." No one who knows Mr. Wallace will have the slightest doubt of his holding steadily to this ideal; no one who knows anything of the problem will fail to realise the intense interest and the supreme value of such a contribution to its literature. We are glad to have the honor of presenting it to the profession, and to all who are or may be concerned with the carrying out of the work.

In short, THE ENGINEERING MAGAZINE holds consistently that the Isthmian Canal proposition is to be solved only by close adherence to the logic of facts. As that logic pointed from the first to the Panama route, so now it alone can guide to the successful construction of the canal on that route.

We are convinced as firmly as ever that there is absolutely nothing in the facts which can or will prevent the complete and triumphant execution of the project, but that completion depends upon the full recognition of the truth. It must be accomplished by frank acknowledgement of and adjustment to the realities of the case and its surrounding conditions. The only serious misfortune which could come to the great enterprise taken over by the United States would be that which would follow any attempt to distort or conceal the truth about the canal work.

This truth, both as to the physical elements and the surrounding conditions, we hope through Mr. Wallace's articles to make fully manifest. The necessary action may safely be left to enlightened public opinion.

* * *

To Mr. Stevens, who succeeds Mr. Wallace as Chief Engineer of the Panama Canal and who comes to the undertaking with the confidence warranted by a record of large accomplishment and excellent administrative ability, displayed in the upbuilding of transcontinental railways, we wish the utmost success. If he finds in his new relations the same power and freedom to express his professional knowledge and skill in constructive work which he has found in the positions wherein he made his reputation, unquestionably he will carry the undertaking to success and his own fame to higher prestige. If, on the other hand, he should find that Government systems and methods, departmental routine, and political standards, are wholly incompatible with the policy and ideals he has found it essential to live by in order to carry out the executive direction of great enterprises, he would in all probability feel compelled by every consideration of professional pride and honor to dissociate himself again from work which he felt it impossible to administer properly under the conditions by which he was surrounded.

In our judgment, the one great menace to the speedy and successful completion of the Canal construction is that, in the management of its affairs both large and small, the Government official and the departmental idea is ascendant over the practical engineer and the engineering idea. That the Government must control in theory, and, as to great questions, in absolute fact, is indisputable. But practical execution of the project will never make adequate headway until the work is placed upon the same basis as other engineering undertakings of magnitude, such for example as the great railway and subway enterprises—committed to a management of unquestioned ability and unimpeachable integrity, with a free hand. The Canal must be built by engineers; it can not be successfully built by politicians.

* * *

THE deplorable accident which occurred near Mentor, Ohio, with the Twentieth Century Limited train of the New York Central and Hudson River Railroad (not the least of its deplorable results being the deaths of Messrs. C. H. Wellman, T. R. Morgan, and Archibald P. Head, widely known in engineering circles) cannot properly be attributed to the high speed of the train, since the cause of the disaster—a misplaced switch—would have made even a worse wreck of a slower train. The disaster is but another argument for the introduction of absolute mechanical control of all operative features in the maintenance of a clear track, a control which shall automatically apply the brakes and compel a stop if, for any reason the way shall not be complete.

Experimental researches, upon the Marienfelde-Zossen electric railway in Germany, have developed the important fact that at the highest rates of speed it is impracticable to depend upon the human perception of the condition of stationary signals, and it is being planned to transfer the signals to the cab in which the motorman is placed, thus enabling him to have before him an electrically controlled indication of the warnings and directions which he might well fail to observe in the infinitesimally short space of time available for the passage of a fixed signal. Similar experiments are in progress in the tunnel of the New York Central and Hudson River Railroad, wherein the dimness of the light interferes more or less with prompt discernment of the hitherto customary signals.

* * *

THIS feature of efficient transport is one which cannot be emphasised too strongly, since it involves a point which appears in various forms in different departments of engineering work. The specialist, devoting himself to some limited portion of an operation, often sees no further, and having accomplished the best result practicable within his limits, fondly imagines that there is nothing more to be done, forgetting that it is the ultimate undertaking which must be considered. The steam engineer often aims to design an engine which shall produce a horse power with the very smallest quantity of steam, while by so doing he adds to the fixed charges an amount which really increases the total cost of the motive power of the establishment. The great ocean liner may break all speed records only to become a heavy source of loss to the company because of the total lack of cargo capacity, and the enormous fuel consumption.

Fortunately the engineer, in becoming, as he is, a man of business affairs as well as a man of applied science, is beginning to realise that the great works of which his efforts form a part are to be considered broadly, and that it is not alone the high spurt of speed, or the low consumption of fuel per horse power, or the isolated *tour de force* in any instance, which is to be considered, but the successful accomplishment of the whole undertaking in the broadest possible manner.

* * *

The ancient ethical formula, known as "The Golden Rule" appears to be appealing not merely to the consciences, but to the pockets of some employers. These claim that attention to the personal comfort and moral surroundings of the employed results not only in laying up treasure in heaven, but increases earthly dividends, presumably, the latter motive in these money getting days being controlling with the majority of business men. Once convinced it is pecuniarily profitable to make surroundings pleasant in manufacturing establishments, we shall doubtless soon perceive a great amelioration in the conditions which now environ manual workers in some departments of industry. How far this can be carried without weakening discipline, or lessening production is a problem not yet worked out to a final solution; but some indication that increased attention is directed to this feature of manufacturing industry may be perceived in fragmentary allusions to the subject in the technical press. It is certain that the conditions which surround labor in many of its most important fields are such as to create the desire for improvement in the minds and hearts of disinterested and philanthropic observers. But it must always be borne in mind, that toil cannot be made synonymous with ease, and that toil is the price of progress in all callings. Some of this toil which is indispensable must be performed in an environment and under conditions that will ever remain repellant.

* * *

AMENDMENT of some terms used in engineering, or the substitution for these terms of more definite terms of expression, is one of the ideas suggested by perusal of Mr. R. M. Neilson's able article on "The Effects of Vacuum on Steam Economy" printed in the present number of this magazine, where he remarks that "it is a pity that condenser pressures are usually expressed in inches of mercury of vacuum instead of as absolute positive pressures." The predication of something positive concerning a negative quantity is an error referred to in all standard treatises upon logic, as liable to lead to erroneous conclusions, and mathematicians will readily recall the ancient trick of making a false proposition appear to be true, without violating algebraic rules, through the use of an indeterminate quantity as a factor in algebraic equations. Other terms long used in engineering technology might be advantageously replaced by terms of more definite import. Why, in indicating pressures of steam or of compressed air, should we be obliged to append the word "absolute" or "gauge" to make clear what is intended? Why should not all pressures be expressed in absolute terms? Prof. Kent, the well-known compiler of engineering data, has gone on record as advocating the substitution of an expression for resistance to passage of heat through materials, instead of an expression of conductivity, and has supported this view with ability. Why should we not always express temperature as reckoned from the absolute zero, a thermometric point established by nature, instead of the arbitrary zeros established by the devisers of arbitrary thermometric scales? If the entire field of engineering technology were scanned for the discovery of terms that have descended to us as an inheritance from eras of imperfect knowledge, it is probable that a number more of these questionings would be suggested.

The discussion of the subject "Progress in Valves of Air and Gas Compressors," by Mr. Leicester Allen in our July number, and an article on "Temperatures in Air and Ammonia Compressor Cylinders," by the same writer, in the current number in connection with the review of Mr. A. L. Mellanby's paper on "The Influence of Steam Jackets" on page 755 of this number serve to illustrate the lack of accurate data relating what takes place in reciprocating engines and pump cylinders while working under approximately the best attainable conditions. The "missing quantity" is demonstrable in all engines and compressors whether steam engines, air compressors or compressors of gases which liquefy by cooling after compression, being least in the compression of air and gases which do not so liquefy. It is inseparable from the operations of either expansion or compression of any one of this class of substances. Among the factors of this missing quantity Mr. Mellanby believes that slippage of live steam into the exhaust ports of slide valves plays an important part, a fact which has also been pointed out by Professor Peabody, and other investigators. The existence of this slip may be considered as an established fact. Doubtless, it varies with different types of slide valves, and is influenced by the perfection or imperfection of fitting, as well as the changes which heat effects in the metals used for the valves and their seats. This view is sustained by the fact that before some types of slide valves can be made to seat even with approximate perfection when live steam is regularly passed through them their seating must be tested by working under steam at the pressure to which they are designed to be subjected in actual work; and, if examination after such testing indicates defective seating they are scraped, often repeatedly, till the indications of imperfect seating disappear. How much of the distortion produced by expansion and contraction becomes permanent after such attempts to perfect the fitting is believed to be an unknown quantity. If a slide valve be perfectly fitted to its seat and prevented from lifting it is difficult to explain how steam in quantity sufficient to generate a notable loss, can pass from the steam chest into the exhaust without first traversing the cylinder. Slip from imperfect fitting of pistons, seems as likely to occur as valve slip, and indicator diagrams should reveal such a defect if it exists in more than extremely limited measure.

* * *

THE defect of valve slip is not confined to slide valves; and although poppet valves may be ground so as to be very tight when at rest under pressure, there is room for more than a suspicion that, while working, more or less leakage constantly occurs with them. The causes of this leakage are well understood, but it is very difficult to avoid them all in practise. Such valves, tested for accuracy of fitting, and, seemingly, satisfactorily meeting the test applied, may in a short time work defectively. Till the arts of valve fitting and piston packing advance to greater perfection there will remain the "missing quantity;" jacketing cylinders will never alone eliminate it from the equation.

* * *

CAN the enormous increase in the output of gold predicted by Mr. Del Mar in the leading article of the current number of this magazine take place without cheapening this metal in the world markets? If so, gold will prove to be an exception to all other articles of merchandise. There are many, indeed, to whom the word gold has been "polarized" in its signification, as our honored, American philosopher, Oliver Wendell Holmes would have said, till it has come to mean in their thinking money only; but there are those who will remember that the demonetization of silver reduced silver, long ranking with gold as a medium of exchange, to a value far below the current value it previously had as money, and that such demonetization by the United States Government was largely caused by the enormous increase in the output of silver. Baron Rothschild is stated to have expressed his belief in the probability that a similar effect upon the price of gold would result from a possible great increase in its output.

* * *

IT is difficult to predict all the effects of great revolutions in any of the industries of the world. But if any one principle of political economy can be accepted without reservation it would seem to be that, where the laws of trade are permitted to work without obstruction or interference, great expansions in production are accompanied by contractions in prices. John Stuart Mill, in his writings on the subject of political economy, declares explicitly that whoever sells anything, receiving money as payment, buys the money as well as sells the goods. What, then, is there in the nature of gold considered as either merchandise or money that will prevent its decline in value, as a result of the expected great increase in the quantity annually thrown upon the market? To be sure, modern commerce is not entirely free from interference with its natural flow. The world does not yet know exactly how to deal with giant syndicates that seem to have been the logical outgrowth of the rapid industrial and commercial evolution of the last three decades. If such an impulse to commerce as would follow the doubling of gold production in ten years is to come, the political and social problems that will inevitably press for solution will be of such magnitude as to tax to the utmost the resources of statesmanship, already seemingly taxed nearly to the limit.

* * *

In view of the developments in the financial world which are shocking public faith, it is not surprising that many who take a pessimistic view of the financial outlook should be apprehensive of a disturbing effect of such sudden and large increase of gold as is prophesied by Mr. Del Mar. The doubling within ten years of the product of any of the world's staples, could not fail to create unprecedented effects upon the markets of the world. The imagination struggles in vain to form a vivid conception of what results would follow the doubling in so short a time of the wheat crop, or the cotton crop, other production remaining about the same, but the status of gold with relation to all other staples of modern commerce is such that its volume could not be suddenly and largely swelled without affecting the price of every other product.

* * *

The discomfort of foul smells and dust in the New York subway are attracting attention. It is impossible, in such a confined space, traversed daily by many thousands of all kinds of people, to prevent a considerable and heterogeneous deposit of organic matter, much of which, particularly cigar stumps, discarded tobacco quids, and fragments of confections and other articles of food which children are permitted by indulgent parents to enjoy while riding in the subway cars, the refuse of which is thrown upon the roadbed from platforms of cars and stations, or tossed out of car windows, becomes a constantly present source of foul smelling emanations. It seems that there is as much need of devising some practical way of cleaning the roadbed, as of supplying more fresh air in the tunnel. It was probably supposed that impure air would be intermittently forced out of the entrances and exits at the stations in currents generated by the movement of trains, and that fresh air would flow in at the same openings, also in an intermittent manner, to supply the place of the vitiated air so expelled. This expectation if it was entertained, has certainly not been fulfilled, at least in such satisfactory manner as to meet the requirements of good ventilation. Those who have regularly patronized the subway complain much of the peculiarly offensive dust, and the odor emanating from the drippings of lubricating oil distributed along the entire track. The four tracks, with trains running on them at short intervals, in opposite directions, operate to generate violent eddies rather than steady air currents setting in any single direction, such eddies acting to keep all floating impurities from settling, whereas they should be carried out of the tunnel to gain the degree of purity which is desirable. Experiments with fan blowers for increasing ventilation are stated to have been inaugurated. To those whose business compels the daily use of this means of traffic, any scheme of really effective ventilation would be most welcome, for it must be admitted that traveling in the subway is still far removed from a degree of refinement that can be accurately characterized as luxurious.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

AMERICAN BRIDGE BUILDING.

A REVIEW OF THE DEVELOPMENT OF MODERN METHODS OF BRIDGE BUILDING IN AMERICAN PRACTICE.

C. C. Schneider—American Society of Civil Engineers.

IT has become the accepted practice among the leading American engineering societies for the president in his annual address to discuss some department of engineering work with which he has himself been actively identified. The result has been the production of a number of papers which may be termed monographs upon the leading departments of engineering, valuable especially because they represent the actual experience of eminent and successful engineers.

At the recent convention of the American Society of Civil Engineers, the president, Mr. C. C. Schneider, took as the subject of his address the evolution of the practice of American bridge building, from which we make some abstracts.

Mr. Schneider reviews the history of early bridge building in the United States, describing the excellent work done in the construction of timber bridges by the carpenter builders before the introduction of railroads. After the development of railways, beginning in 1829, iron bridge building began, and many of the earlier iron bridges were directly imitated from the earlier wooden structures. It was not until Whipple evolved the scientific method of bridge designing and building that the correct method of determining strains was used, this being followed, in the period between 1850 and 1860, by the work of Fink and of Bollman, and by the construction of the Whipple and the Pratt trusses.

In these early bridges cast iron was extensively employed, wrought iron being used in the tension members only. The wrought iron tension members at that time usually consisted of round bars with screw ends, or elongated links made with square bars. The latter construction developed into the flat eye-bar, this being due to Linville, in 1861, and forming a distinctive feature in American bridge design ever since.

"Near the end of the sixties, when most of the early bridge companies had been formed, there were, besides the engineers interested in bridge building firms, only a few experienced bridge engineers in this country. The engineers who were at that time connected with bridge companies were mostly men who had gained their experience in the employ of some railroad company, had worked out their own type of construction, and had experience, not only in designing, but also in superintending the construction and erection of bridge work. Their theoretical knowledge, measured with the present standard, was limited to elementary methods, but their thorough practical training enabled them to combine theory and practice to the best advantage. They understood how to make their designs conform to the methods of the workshop, as well as to facilitate erection.

"This was really the beginning of the development of American bridge building and of the distinctly American types of construction which at that time differed so materially from those of other countries. The most distinguishing feature of the methods then prevailing in this country, as compared with those of other countries, the influence of which is felt to the present day, is that at that time in America the bridges were designed by experienced specialists, and the work was constructed in shops built and equipped for that special purpose by experienced mechanics trained in that class of work. At first these companies controlled the work in certain territories, or the contracts were awarded to them on account of the reputation of their engineer.

"However, as competition became keener, railroads desired to purchase their bridges for the lowest price, and invited several firms or companies to submit tenders on the bidders' own designs, which started the competitive system of designing and bidding on bridge work."

It was not until about 1872 that the modern specification method came into use, the general requirements only being stated, and the design of the structure and the proportioning of details being left almost entirely to the builder, the bridge being accepted on his reputation. After 1873 the modern bridge engineer appeared in the field and the employment of inspectors of material and workmanship was included. From the construction of the Eads bridge accross the Mississippi at St. Louis in 1874, down to 1894, wrought iron was gradually replaced by steel, and at the present time it is practically impossible to obtain wrought-iron shapes.

"The use of steel in the construction of modern bridges, and the improvements made in its manufacture, thereby reducing its cost and increasing its reliability, have made it practicable to build structures of a magnitude never attempted before. Its introduction as a structural material had a marked influence on the progress and development of bridge building. Certain types of construction and details which have proved unsatisfactory have been discarded, and others which have undergone a process of purification and improvement have survived. Rational types of construction and details are now established, and have become the recognized standards for ordinary bridges of moderate spans. The present tendency is toward uniformity, and to-day there is but little difference between the designs made by competent engineers.

"This tendency toward uniformity has also been extended to specifications for bridges and other steel structures, relating to quality of material, workmanship and unit strains. As late as five years ago, the requirements specified for the quality of steel were numerous, almost every railroad or bridge engineer requiring some different grade, and sometimes several different kinds in different parts of the same structure. Erratic specifications are now gradually disappearing, and engineers at the present time are nearly all agreed on the grade of steel best suited for structural work."

At the present time there is a tendency towards closer uniformity between European and American practice in bridge building than formerly, each country gradually adopting the good points in the other's practice. Designs have been materially modified by reason of the steady increase in the weights of locomotives and rolling stock, while bridges are now expected to be able to stand up under the ordinary contingencies of traffic, such as derailment, a broken axle, or a collision on a bridge.

"Any engineer who has followed the progress of American bridge building for the last 35 years must have observed that, not only the designs, but also the methods adopted for accomplishing results, have undergone a vast transformation; while, abroad, the designs have beenn improved, but the methods have changed very little, if at all.

"The practice of having designs of bridges and other structures made by engineers employed by the purchaser, and letting the contract to a manufacturer on a pound-price basis is now becoming the standard practice of the country. Most of the large railroads have their own bridge and structural departments, or, for work of unusual magnitude, employ outside experts to design and supervise construction. Only a few of the smallest railroads adhere to the ancient practice of inviting manufacturers to submit competitive designs accompanied by a lump-sum bid.

"The competitive system has had its day and has served a good purpose. It has been an important factor in developing the art of bridge building in America. It has been productive of establishing rational types, practical details and scientific proportions; it has united theory and practice.

However, at present, it is fast becoming a thing of the past. What is left of this practice is mostly confined to bridges for electric railways and light structural work. Many purchasers of structural work, who have had no experience themselves, do not seek professional advice, as they would in other cases where large expenditures of money are involved, believing that they can save the money paid for professional services by inviting manufacturers to make competitive designs accompanied by a lump-sum bid. The fact is, however, that the manufacturer has to pay for making the designs not only once, but many times over, as only once in a number of cases is he the successful bidder. The manufacturer will naturally add this extra expense to the cost of the structure, yet the designs are not made in the interest of the purchaser, but in that of the manufacturer. This practice has a demoralizing influence, as it puts a premium on the poorest design and tends to decrease the professional standard of an important branch of engineering.

"The standard practice to be recommended, as the only fair and businesslike method, is to let contracts for structural steel work on a pound-price basis, on designs and specifications furnished by an experienced engineer employed by the purchaser. This method is fair to the honest manufacturer, as all competitors bid on the same basis; it is an advantage to the purchaser, as he employs the engineer who will protect his interests, study the conditions and requirements, and design a structure to suit the needs of his client. It will benefit a number of engineers, who are now compelled to waste their time and energies in making speculative designs to suit the commercial interests of a manufacturer, regardless of good practice, by elevating them to more independent positions, thus enabling them to raise their professional standards to the highest ideals of good practice."

Mr. Schneider distinguishes clearly between the work of the engineer and the bridge builder, and his remarks in this matter may well be applied to other departments of engineering work, notably to the design of tall buildings, dams, embankments, and similar structures.

"Plans for bridges and other structures, on the safety of which the lives of human beings depend, should be designed and not manufactured; their design and the supervision of their construction should be entrusted only to competent engineers, who, besides the requisite theoretical and practical knowledge, should, above all, be endowed with common sense and good practical judgment.

"Most of the largest bridges and other steel structures which have been built in later years have been designed by engineers not connected with manufacturing establishments. The manufacturer should confine himself to his legitimate field of manufacturing structural work at so much a pound.

"The line between engineers and manufacturers will be even more marked in the future, when the same distinction will prevail as now exists between the architect and the contractor. The manufacturers of structural work, in the future, will devote their energies to improvements in their tools and machinery and methods for handling material. Their engineering force will consist of mechanical experts, shop draftsmen and engineers, who, with a thorough knowledge of shop-practice, are skilled in putting the engineers' designs into convenient shape for the workshop."

LARGE GAS ENGINES.

RECENT DEVELOPMENTS IN THE DESIGN AND CONSTRUCTION OF LARGE GAS ENGINES ON THE CONTINENT.

R. E. Mathot—Institution of Mechanical Engineers.

IT is a matter of interest to note that the development of the gas engine has varied greatly in different countries. In England, and to a great extent, in the United States the small engine has been extensively made and used, the advantages of convenience outweighing the cost of illuminating gas as a fuel. On the Continent, however, the gas engine first developed into a machine capable of entering the field of prime movers of large size, competing with the steam engine in dimensions and power, and far excelling it in thermal efficiency.

At the Liége meeting of the Institution of Mechanical Engineers, Mr. Rodolphe Mathot, well known to the readers of this magazine as an authority on gas-engine design and operation, presented a paper upon the growth of large gas engines on the Continent, showing the extent to which the internal-combustion motor has become a competitor with the steam engine in Europe.

"The development of large gas-engines can be said not to date back further than five to six years. Eight to ten years ago they were initiated simultaneously in Germany, England and Belgium, early attempts being made to utilise blast-furnace gas, which was expected to open up such a vast field for the employment of large engines. Although the first trials were only attempted on small engines, the results of the experiments soon gave encouragement to the efforts of the investigators. The Cockerill Co. of Belgium constructed a single-acting Otto cycle engine of 200 horse power, which has been working regularly at their establishment for six years. This stage in the path of progress was strongly accentuated by the 600 horse power engine on the Delamarre-Deboutteville system, which the Cockerill Co. exhibited at the Universal Exhibition at Paris in 1900. This magnificent engine was single-acting, the piston having a diameter of 1.300 m. and a stroke of 1.400 m. It was designed to develop its power at 80 revolutions per minute, which, with an initial explosive pressure of 310 to 325 lbs. per square inch, produced on the piston a pressure of 300 tons at each explosion. In a short time several famous firms entered, in their turn, upon the construction of large engines intended to utilise the gases liberated by the various reactions occurring in the manufacture of iron, coke, &c., and the metallurgical industry was not long in entering upon the path of progress by replacing for its old boilers and engines powerful installations of explosion engines. It remained, however, to conquer the vast domain of manufacturing industry. It is in this sphere that the struggle is taking place with the steam-engine, which a long career has endowed with improvements in methods and execution. The physical laws which govern the production and utilisation of steam as a motive power have long been known, having at an early date emerged from the obscurity which developed their interpretation, and thermodynamic science has given them definite sanction by numerous investigations.

"Improvements in construction advanced side by side with the progress of scientific theory to accomplish mechanical marvels. Steam is, however, a fluid much less complex in nature than explosive mixtures. The action of steam is governed by precise laws which pertain only to the sphere of physics, whilst the production of combustible gases and their mode of evolution under the form of explosive mixtures in engines, are as much within the domain of chemistry as of physics and mechanics. Although the generic theory of gas-engines has rested up to the present on a series of hypotheses which have not yet received experimental confirmation, these engines have gained ground in application to various industries with exceptional rapidity compared with any other kind of motive power. The invention of gas producers and the improvements made in the last few years, and especially in those working with the direct suction of the engines, are manifestly most important factors in this success."

In discussing the various elements involved in the operation of the gas engine, Mr. Mathot considers first the question of regulation, showing how the "hit-and-miss" method, so generally employed for small engines, has been entirely abandoned for the larger machines. The present methods act by controlling the mixture of the charge, and especially by the admission of a variable quantity of a mixture of uniform composition. A variety of admission valve systems are shown in the paper, using auxiliary throttling valves, valves with variable stroke, and similar devices.

The valve control, in the modern large engines, resembles somewhat that of the best types of poppet-valve steam engines, such as the Sulzer engine, cams being replaced by eccentrics and roller-path levers.

The question of cooling demands especial attention in large gas-engines, since the heavy pieces are extremely liable to crack if unequally heated. The method of circulating the cooling water has an important influence upon its effective action, the best effect being obtained by placing the inlet and exhaust valves in the same vertical axis, both being in a passage, or ante-chamber, surrounded on all sides by the cooling water. For engines of 100 horse power or more the exhaust valve is also provided with an internal circulation.

The advantages of high compression are fully realized, and at the present time the compressions used range from 170 to 200 pounds per square inch. The head produced by such a compression is liable to cause pre-ignition if the cooling is not effective, and in the Koerting engine there is a hollow casting arranged inside of the explosion chamber provided with a special water circulation for cooling purposes. In double-acting engines the water cooling includes not only the cylindrical jacket and cylinder ends, but there is also provided an independent water circulation for the piston and piston rods, the seats of the exhaust valves, and the stuffing boxes.

An important feature in the successful operation of the internal-combustion engine is the ignition, and at the present time the use of the magneto, producing a spark on the break of the circuit has ousted all the older methods of ignition, such as the incandescent tube, the spark produced by batteries and accumulators, by dynamos, etc. The use, in large engines, of greater volumes of lean gas has led to the use of two igniters, one placed near the inlet valve at the top, and the other at the bottom near the exhaust valve.

Large engines are now generally started by compressed air, a lever or system of gearing being used to bring the crank to the correct position.

Mr. Mathot gives formulas for the computation of the proper weight of flywheel for engines with various arrangements of cylinders, and for different classes of service, and also discusses the various systems of lubrication in use.

The mechanical efficiency of the four-cycle engine now reaches as high as 90 to 92 per cent., while the two-cycle engine attains about 75 to 80 per cent., the difference representing the work absorbed by the air pump and the gas pump. The thermal efficiency of the double acting four-cycle engine may be as high as 28 to 30 per cent., corresponding to the production of a horse power with an expenditure of 8,729 British thermal units per hour.

The details of modern large gas-engines are very fully shown in Mr. Mathot's paper, these representing the practice of the best modern builders of the Continent, the performance being shown by indicator diagrams. Even with all the care and skill which has been given in design and construction there are certain difficulties which remain to be overcome in order to enable large engines working with lean gas to work with safety, facility of control and satisfactory upkeep.

"Economically the gas-engine is evidently superior, but low consumption is not the only quality which users require from a motive power. It is necessary above all that it should be free from the risk of sudden stoppages which lead to great expense, as they hamper production and may be at times fatal in certain industries where breakdowns must be specially avoided; such is the case with electric stations, pumping, hoisting and ventilating work in mines, etc. The principal causes of breakdowns in engines fed by gas other than town gas, which undergoes a complete purification, consists in the fouling of parts, such as the pipes, the valves and the cylinder, by impurities in the gas.

"In large installations where it is extremely important to avoid breakdowns, recourse is had to special means of washing and purifying, by the use of centrifugals and other apparatus. But although these succeed in reducing to 1/5 gramme per cubic metre the amount of dust accompanying the gas, they still allow the passage of tar, which is the principal element destructive to the engine. This tar adheres to the sides of the passages, causes the valves and piston rings to stick, thus preventing their proper action. It also deposits itself in the cylinder where it finally gives rise to premature ignitions. Certain coke-oven gases contain as much as 1 gramme of tar per cubic metre. It is this very question of tar which compels us, in order to avoid great complications, to employ exclusively non-caking anthracite coal for suction gas-producers now so largely in use owing to their simplicity and economical efficiency. As tar is a product of distillation of the volatile carbons (carbides) which escape on combustion and on the conversion into fuel gas, it is to our interests to reduce them in the producer itself. Different systems have been proposed, amongst which is the system of *inverted combustion,* which is said to have the result of burning the volatile matters as they are given off and the *distillation* of the hydrocarbons in the independent reducers. It must be admitted that so far the efforts of the inventors have not met with the success expected. The caking of the fuel and the formation of cavities injurious to the regularity of combustion constitute the principal difficulty to combat. The use of bituminous coal, especially in suction gas-producers, is not therefore a question which has been industrially accomplished.

"Whether it is producer gas, blast-furnace gas, or coke-oven gas which is used, their purity is an important factor in the proper working of the engines which they feed. The organic defects of large engines do not appear to play in this respect a preponderating part. They should, however, be perfected as regards facility of access and upkeep of the parts, such as valves and piston. The oil consumption should be low, and they should be made less susceptible to variations in the quality of the gas. The skill of our experts and our makers will, we have no doubt, soon overcome these latter difficulties. Large gas-engines will then constitute one of the most remarkable industrial victories of the age in which we live."

ELECTRIC POWER SUPPLY.

THE PRACTICABILITY OF SUPPLYING CHEAP ELECTRICAL ENERGY FOR INDUSTRIAL PURPOSES.

J. A. Jeckell—Birmingham Electric Club.

MUCH has been said and written about the engineering features involved in the establishment and operation of electric generating stations, but it is not always realized that the fundamental object of such undertakings is not to make electricity, but to make money. For this reason the paper recently read before the Birmingham Electric Club, by Mr. J. A. Jeckell, is of value, treating as it does of the commercial side of electric power supply, and of the advantages to be gained in the reduction of costs to the producer and of prices to the consumer.

In the early days of the introduction of electricity the current was mainly used for lighting, and the original customers paid a high price for the supply, so that good dividends were made without requiring close attention to be paid to the cost of operation. The stations were engaged in supplying what has been termed the luxury demand, which was very satisfactory while it lasted, but could not wisely be taken as a basis upon which to plan future operations.

The true methods upon which a commercial undertaking of this sort should be carried out are clearly stated by Mr. Jeckell to be: the expenditure of the smallest amount of capital; the production of the article at the lowest possible figure; the selling of the largest possible amount of that article; and an arrangement by which the payment of the manager may largely depend upon the financial results which obtains.

"When local authorities decided to undertake the supply of electric energy, the only course open to them was to consult an expert. Unfortunately, from the view of profit-making, the consulting engineer was not in every way a most desirable person to give advice; being pre-eminently an engineer, he would naturally not look so much to the commercial aspect of the undertaking as he would to the engineering side. It should be remembered that for an engineer commercial knowledge is in some ways a disadvantage. Undoubtedly there is another side to the question, but in successful engineering money may have to be a secondary consideration, and therefore it is not to be expected that consulting engineers should be good commercial men. It is well known that consulting engineers are paid a percentage on the capital outlay, and, therefore, while for not one moment suggesting that a good consulting engineer would on this account recommend increased expenditure, still it must not be forgotten that this percentage does not depend upon the commercial success of the undertaking. Furthermore, the number of consulting engineers who had actually designed, put down, run, and made a commercial success of an electricity supply station was, and is still, limited.

"The old Latin proverb *Experientia docet* has a great deal of truth in it, and unless a man is a Heaven-born genius, of which there are few examples in this world, he is not likely to be well acquainted with matters of which he has not had previous experience. However, for local authorities there was no choice in the matter; they had to go to the only men available to advise them with regard to putting down their works. These engineers would be inclined to follow the principle adopted frequently in gas and water works, and erect fine handsome buildings, which are all very well in their way, but do not reduce the cost of manufacture. Further, these engineers took far too limited a view with regard to the supply of electricity in the future. Stations were designed purely for lighting purposes, and too frequently no provision was made for large future extensions. Further, these engineers who designed the stations apparently favoured land practice rather than marine practice. It is, of course, well known that it is more important to have highly economical engines on board ship than on land, because in the former case not only has coal frequently to be purchased at foreign ports at an enormous figure as compared with the prices ruling in England, but for every ton of coal not required a ton of cargo can be carried. Marine practice was, therefore, to use the most efficient steam-engines possible. Compound condensing engines had given place to the triple-expansion condensing engines, and these in many cases had been superseded by quadruple expansion engines. Engineers who designed the electricity works, for the most part, ignored all this experience, and installed compound engines non-condensing, either horizontal or vertical. Of course, these were cheap to buy, and as long as electricity was only used to meet the luxury demand for lighting, the load factor of the plant being only some two hours per day, the want of economy of this type of plant was not of so much account."

Mr. Jeckell gives practical illustrations of the working of actual stations, showing the advantages to be obtained by the careful design of plants capable of economical performance over a long range of power. Such installations include the use of large, surface condensing power plants, instead of small non-condensing engines, the irregularities in the load being taken care of by the power range of the engines instead of attempting to throw smaller engines in and out of service to meet the fluctuations in the demand.

"The chief thing we have to bear in mind with regard to the supply of electricity for power purposes is that the energy must be sold cheaply. In order to do so we must get down to the rock bottom cost of manufacture. In considering this question, the *capital* cost of the plant is really a secondary consideration, because if the plant is run 12 hours per day the capital is not increased, but, on the other hand, the maintenance is probably increased, the wages are increased a little, the oil is not increased much. The chief item we have to consider is the coal consumption, because after the stand-by charges are paid the coal consumed will be in proportion to the number of hours the plant is run. The author particularly wishes it to be understood that he does not mean that the open-type marine condensing engine is the *only* engine for use in power stations. The moderate-speed enclosed type and the turbine under certain circumstances will probably do equally as well, but local conditions will decide this."

As an example of the manner in which the cost per unit can be lowered by a judicious rearrangement of the plant, combined with a vigorous effort to increase the output and sale of current, Mr. Jeckell cites the case of the Coventry Corporation Electricity Works. Here a plant which was yielding no profit was extended by an expenditure involving a doubling of the capital, while the amount of current sold was increased more than six-fold. The station cost per unit, or kilowatt-hour, was reduced from 3.43 pence to 0.85 penny, while the price to the customer was lowered from 4.27 pence to 2.28 pence. At the same time the profit was increased from 1.44 per cent. to 6.47 per cent. upon the total capital, and deducting the profit made in 1900 upon the original capital, it appears that a profit of more than 10 per cent. has been made upon the extra capital spent since that date.

That the supply of electricity for power purposes at a very cheap rate is advantageous would seem to appear without requiring demonstration, but Mr. Jeckell gives a number of arguments to show the especial advantage to the United Kingdom of a cheap supply of electric current. Thus the severe competition which British manufacturers are obliged to meet renders it especially important that power should be supplied to manufacturers at a low price. Again, the provision of a supply of cheap power will aid in maintaining the industries of the smaller towns, and prevent them from being suppressed in favor of the larger manufacturing centres. The advantage of this from a sanitary viewpoint is fully admitted, while the commercial gain is also evident. The general introduction of electric power distribution would also result in an increased development in the business of the manufacture of electrical apparatus, cables, motors, and other machinery, so that the results of a cheap and abundant supply of electrical energy cannot but prove a great benefit to the nation, to the various localities, to the public health, and to the undertakers.

AUTOMOBILE MILITARY TRACTION.

THE APPLICATION OF AUTOMOBILE HAULAGE TO HEAVY ARTILLERY SERVICE IN THE PORTUGUESE ARMY.

Col. G. Espitallier—Le Génie Civil.

THE applications of automobiles to military service have thus far been attended with but limited success. Experimental trials have been made in England with machines especially designed for this service, and some fairly satisfactory results obtained. At the same time, the onerous conditions have prevented complete success from being attained, and it is undoubtedly the opinion of most military men that the vigorous service now rendered by horses cannot be effectively replaced by machinery. At the same time there are certain departments of military work, involving the haulage of heavy trains of artillery or munitions along regular highways, in which the automobile may well be found more effective than animal traction, and to this matter serious attention has been given in various countries. In a recent issue of *Le Génie Civil*, Lieutenant Colonel Espitallier describes the efforts which have been made to apply automobile traction to a battery of heavy artillery in the army of Portugal. As this battery represents the latest work of the great Creusot Works it cannot be regarded as an ill-considered experiment, but rather as a serious effort on the part of an establishment of high reputation, to solve a difficult problem.

In the trials made in England under the auspices of the War Office, it was decided that steam vehicles were inadmissible for military purposes, owing to the difficulty of obtaining water, and, indeed, this appears to be an insurmountable obstacle, especially in some parts of the world where mechanical traction would be most desirable. Apart from the question of water supply, there are other objections to machines using coal or coke as fuel. The weight of the fuel alone is a serious matter, and it has been estimated that a motor of 25-horse power would require about 80 kilogrammes of combustible, and 400 litres of water per hour, all of which would, in most instances, have to be carried, thus seriously diminishing the effective capacity of the machine. The production of smoke by day and of sparks by night, form also serious defects in a machine intended for military service. For these reasons it was decided to rely upon an internal-combustion motor, and in the case under consideration it was decided to use a motor of the Brillie type.

The battery to be hauled consisted of four Canet guns of 150 millimetres bore and 14 calibres length, throwing a projectile of 40 kilogrammes weight with a velocity of 350 metres. The full road weight of the train, including the four pieces, with supplies, ammunition, spare parts, etc., including the automobile tractor itself, amounted to 26 metric tons, the machine alone weighing seven tons.

The motor is a four-cylinder machine, developing 35 horse power at 900 revolutions, and is arranged to use either alcohol or petrol as fuel. The speed gear is arranged to permit four changes, ranging from 2.4 kilometres to 14 kilometres an hour on the road. In actual service it has been found practicable to maintain a speed of five to seven kilometres per hour upon a good level road, this speed falling to two to three kilometres up grades of 5 to 7 per cent.

The consumption of fuel is found to be about two litres per kilometre, corresponding to 0.075 litre per ton-kilometre total. The machine is arranged to carry 180 litres of fuel, and 30 litres of water, this being sufficient for a journey of 80 kilometres in length.

An important feature of the machine, and one adapted from experience with the Powler traction engines in the British service in South Africa, is the provision of a winding drum on the tractor. By this means it is practicable to overcome heavy resistances or to pull the train out of a bad piece of road or up a heavy grade, using a wire cable, and either attaching the rope to a fixed point ahead and winding up the whole train, or else sending the tractor ahead and using it as a winding engine to pull up the balance of the load.

It is apparent that if automobile traction is to find practical application in military service it must begin by some such intermediate work as that here described. The field battery must be capable of being drawn into any position over any kind of country, and for this service there is nothing in sight which can approach animal traction. Recent military experiences, however, show that the ability to bring up promptly a heavy train of artillery even if limited to the lines of main highways, may be of vital importance, and the demonstrations which have been made with this equipment have shown the value of mechanical traction in warfare.

SUPERHEATERS FOR LOCOMOTIVES.

PRACTICAL EXPERIENCE WITH SUPERHEATED STEAM IN LOCOMOTIVE ENGINES IN AMERICA.

H. H. Vaughan—Railway Master Mechanics' Association.

AMONG the papers presented at the recent meeting of the American Railway Master Mechanics' Association was one by Mr. H. H. Vaughan, showing the remarkable extent to which the application of superheaters to locomotive engines has attained. Superheating was early recognized as of value for steam engines of all kinds, but after considerable experience it was gradually abandoned because of difficulties experienced with the lubricants, packing, etc. More recently its use has been revived, both in Europe and America, and with the improvements in methods and materials of construction the former difficulties have been avoided.

Although experiments had been made upon superheating in locomotives in the United States as long ago as 1870, the present interest in this line of work really dates from the more recent experiences of Garbe and Muller in Germany, and a paper of Herr Garbe, presented about three years ago before the Society of German Engineers, was reviewed at the time in these pages. At the present time it is estimated that there are about 200 locomotives in Germany running with superheated steam.

In America the Schmidt superheater, practically identical with that so successfully employed in Germany, was introduced by Mr. Roger Atkinson upon the Canadian Pacific Railway in 1901, and the results were so satisfactory that by 1904 41 engines were built equipped with the Schmidt and the Schenectady superheaters. During the present year, 1905, the Canadian Pacitic Railway is building 55 simple ten-wheel freight engines, and six Pacific type passenger engines, which will be equipped with superheaters of various designs, so that comparative results may be obtained. The design of superheaters used on locomotives is at present limited to three types. The original Schmidt design is provided with a tube of large diameter leading from the firebox to the front tube sheet, delivering a portion of the hot gases into an annular chamber at the front end, within which the superheater tubes are placed.

In the Pielock superheater the boiler flues pass through a superheating chamber in the middle of the boiler; while in the Schenectady superheater, and in a modified form of the Schmidt, the superheating tubes are inserted into the upper boiler flues, these being made larger than usual.

Mr. Vaughan gives results of a number of trials, both in Europe and America, showing in every case a material gain by the use of superheating. Broadly, the practical experience which has been thus far gained shows an economy of about 30 per cent., and it is upon this basis that the Canadian Pacific Railway Company has felt justified in going so extensively into the introduction of superheaters in its new engines.

"The use of superheated steam does not entail the multitude of practical difficulties that so generally accompany any invention or improvement that is introduced to improve the economic results obtained from a locomotive, and, indeed, it is probable that as experience with its application develops, some of the expenses that are incurred in the locomotive of to-day will be diminished rather than increased. There would only appear to be two possible sources of additional cost, the wear of valves and cylinders due to defective lubrication, and the cost of maintaining the superheater itself. So far as has been learned at present, the lubrication of superheater engines is not different from that of other engines, with the exception that the lubrication must be accomplished, and it is not sufficient to hope that the oil gets to the designed spot. For this purpose a positive feed lubricator is required, and this should preferably be provided with six feeds, so that pipes may be led to each end of the valve and to the cylinder. It should also be possible to vary considerably the amount of oil fed per minute, as superheater engines, even more than those of the ordinary type, require more oil when working slowly at long cut-offs, than at other times, on account of the high temperature of the steam being maintained throughout the stroke This can be effected either by supplementary oiling or by an easy adjustment of the lubricator, allowing a large amount of oil to be fed at low speed, but the latter will be preferable if obtained without complication. With proper lubrication there appears to be no additional wear of valves or pistons, and while a special mixture of metallic packing must be used, it has given, if anything, less trouble on the superheaters than on the other engines.

"The repairs to the superheater proper are at present difficult to determine; the smoke-box superheater certainly entails an additional expense when flues are renewed, as it has to be entirely dismantled in order to get at the tube sheet, but while it is said to have given some trouble in service in Germany, such has not been the case in three years' experience on the Canadian Pacific Railway. Some trouble was at first experienced with the joint between the large tube and the back tube sheet, but this was overcome by properly thinning the edges of the lap, as in fire-box construction. There has been no leakage from the various joints in the front end and, in fact, so far nothing has developed that would lead to any additional expense in maintenance.

"A possible advantage of superheating has not been utilized in its application in America, namely, a reduction in boiler pressure without loss in efficiency, although in Germany this has been usual. There is no doubt that the increase of pressure from 175 to 200 and 210 pounds that has taken place within the last few years has been of doubtful advantage. While there is a gain in economy, this is accompanied by an increase in the losses due to leakage, both in engine and boiler, and by a considerable increase in the cost and trouble of boiler maintenance. By superheating, the initial pressure becomes of less importance and with the proper amount of superheat, it will be possible to return to pressures of 175 pounds or less, without any appreciable loss in economy, and with a relief from those boiler troubles, which have become more serious as the pressure has increased, it is probable that the saving from this cause alone will overbalance any additional expense connected with the maintenance.

"In general, it may be assumed that the maintenance of locomotives using superheated steam will not be necessarily greater than that of ordinary locomotives of similar size, as although certain additional expenses are introduced, these are offset by economies in other directions, and the net result will not be very much different. If this position is correct, the advisability of superheating depends entirely on the relation between the initial additional cost and the saving obtained, and as, at present, the cost of applying a superheater is about $1,000 per engine, and the tendency will be rather to reduce this amount than increase it, it is evidently a very good investment. A 200,000 pound freight engine making 30,000 miles per annum, will burn about 2,500 tons of coal, which at $2 per ton, costs $5,000, so that evidently a saving of 10 per cent. will pay 50 per cent. of the additional cost per annum, and it appears perfectly safe to state that with a superheater at least that amount can be saved. When slightly more expensive, at first cost, than compounding, there is in the application of superheated steam a possible development in locomotive engines, and without complication in its construction, which costs no extra for maintenance, does not reduce the efficiency of a locomotive in any way as a mover of freight, and which, without any desire to appear too enthusiastic, certainly promises to become one of the greatest steps in the direction of economy that has been introduced for many years past."

LIGHTNING PROTECTION.

MODERN METHODS OF PROTECTING BUILDINGS AND OTHER STRUCTURES FROM INJURY BY LIGHTNING.

Killingworth Hedges—Society of Arts.

IT is an interesting fact that one of the earliest practical applications of electrical research, the lightning rod of Franklin, should have had, first a great vogue, followed by a certain amount of discredit, only to be revived, under renewed conditions of scientific study and interest. The history of methods of protection against damage by lightning, together with a review of present approved appliances, forms the subject of an interesting address delivered before the Society of Arts by Mr. Killingworth Hedges, and published in the *Journal* of the Society.

After referring to numerous records of damage by lightning from very early times, Mr. Hedges describes the work of Franklin, in 1752, and calls attention to the fact that Sir William Preece stated before the British Association for the Advancement of Science in 1888, that if one wanted to know much about atmospheric electricity one had to go back to the works of Franklin, 140 years before. Down to the year 1881 there was not even a code of rules in the United Kingdom to guide people in protecting their buildings from the destructive effects of atmospheric electricity. At that time the first set of rules was framed by the British Association, but little was really done until 1901, when the Lightning Research Committee was organized in Great Britain jointly by the Royal Institute of British Architects, the Surveyors' Institution, and the Meteorogical Society. About the same time the Electrotechnische Verein, in Germany, took up the subject, discussing and framing rules and recommendations for the protection of buildings, so that the subject is now fairly on a modern scientific basis.

After describing the work of the Research Committee in securing reliable information concerning damage by lightning strokes, Mr. Hedges describes the modern theory of lightning discharges, and the methods of rendering them harmless.

"It has been pointed out by Sir Oliver Lodge that lightning discharges are of two distinct characters, which he has named the A and the B flashes respectively. The A flash is of the simple type which arises when an electrically charged cloud approaches the surface of the earth without an intermediate cloud intervening, and under these conditions the ordinary type of lightning conductor acts in two ways; first, by silent discharge; and secondly, by absorbing the energy of a disruptive discharge. In the second type, B, where another cloud intervenes between the cloud carrying the primary charge and the earth, the two clouds practically form a condenser; and when a discharge takes place from the first into the second, the free charge on the earth side of the lower cloud is suddenly relieved, and the disruptive discharge from the latter to the earth takes such an erratic course that no series of lightning conductors of the hitherto recognized type suffice to protect the building."

Experiments show that the material of which a conductor is composed has an important influence upon the action. The disruptive discharge to copper is far louder and more intense than that to iron, while that to wet string was still quieter. It is interesting to recall in this connection the fact that in the famous experiment ot Franklin, the wet kite string formed the conductor. The experiments show that iron is a very useful material for lightning rods, as the effective energy of a flash of lightning is rapidly dissipated in iron.

"Absolute protection of the whole of a building could only be assured by enclosing the whole structure in a system of wirework—a contrivance, in fact, of the nature of a bird-cage. This should be well connected at various points to the earth, as nearly all buildings have gas and water pipes and other metallic conductors in their interiors which are likewise earthed. For structures intended for the manufacture of storage of gunpowder and other explosives, the adoption of this bird-cage protection would be justified on the score alone of public safety. Architectural considerations prevent the adoption of such a method in its entirety for ordinary buildings. There is no doubt, however, that practically perfect protection may be assured by a judicious modification of the existing practice of erecting single lightning rods, especially in the case of extensive and lofty buildings that project well above surrounding structures, or that stand isolated in the open country."

The old theory assumed that the electricity ran off through the rod, much as water through a pipe, and hence the effectiveness of a rod depended upon its electric conductivity. As a matter of fact the copper is too good a conductor, allowing the discharge to pass too quickly, producing a shock of much violence. An iron conductor offers more impedance to the current, and allows it to leak away by damping down the oscillations, so there is less chance of a side flash from an iron than from a copper conductor.

"The characteristics of a flash of lightning which more particularly concern us are:—(1) surging, that is due to the oscillatory character of the spark which, unlike the currents employed for conveying electricity to a distance for lighting cities or driving tramcars, is a disruptive discharge, sudden and violent, more like the blow of a hammer; (2); self-induction, a property which gives rise to counter force or choking effect, noticeable in straight wires, but which is much more pronounced in coils of wire; (3) side flash, the result of self-induction. A disruptive discharge will often leave what would ordinarily be called an excellent conductor and side flash through the air to other much wore conductors; for instance, the lightning rod may be struck, but instead of following the course provided, a side flash may select its own path through a wall of brick or stone to a neighbouring gas-pipe or bell-wire."

Side flashes may be sources of great danger, and iron or wire fences have been repeatedly observed to cause the deaths of live stock in this manner by lightning.

"The principal causes of the failure of the usual style of lightning-rod as fitted on the buildings investigated, appear to be due to the following: (1) insufficient number of conductor and earth connections; (2) the absence of any system of connecting the metallic portions of the buildings to the lightning conductor, especially the interconnection of the finials, rain-water pipes, and gutters. In the author's opinion the frequent damage by sideflash from the conductors might be lessened by running a horizontal conductor along the ridge or along the parapets of all the roofs, somewhat after the method which is almost universally adopted in Central Europe.

"The lightning strokes may be divided

into three classes:—(1) Those where the conductor conveyed a portion of the flash to other unearthed metallic conductors damaged the building; the practice of running the conductor round the projecting masonry, often taking sharp bends, doubtless facilitated the deviation of the current from its direct path to the earth; (2) in several observations a metallic roof of large area received the flash, consequently became highly charged, and the single conductor failed to convey the whole of the stroke, a portion of which took a circuitous path, for instance, through a speaking tube and an electric bell wire; (3) a flash struck the building at two points simultaneously, a lightning conductor taking one part of the stroke, but damage was caused by the other portion selecting an unprotected part of the roof."

Theoretically the best method of protecting a building is to enclose it in a sort of bird-cage of metallic conductors, properly earthed. This, of course, cannot be literally effected, but the principle can be carried out very closely without being made at all conspicuous or offensive. No general rules can be given, as each case must be arranged according to the special conditions. Vertical conductors should be run from the highest points to earth, with horizontal conductors along the ridges of the roof, connected to all salient ironwork, guttering, and rainwater pipes. The air terminals need not project much above the highest points, but great attention should be given to the grounding. An earth, to be of use, must be of low resistance, and that is only obtained in moist ground. If this is not easily obtained, the best way to keep the earth connection damp is to run a small pipe from the nearest rain-water pipe in such a manner that some of the rainfall is diverted directly to the metal plate

THE EDUCATION OF RAILROAD EMPLOYEES.

METHODS OF PROVIDING TECHNICALLY TRAINED MEN FOR RESPONSIBLE POSITIONS IN RAILROAD SERVICE.

George M. Basford—Railway Master Mechanics' Association.

IN all departments of engineering work the necessity for providing men who shall not only be competent but also technically responsible, has become a pressing problem. Especially is it becoming so in railway work, owing to the tremendous growth in operations as compared with the simpler methods and smaller scope of work a few years back. In a paper presented by Mr. George M. Basford, before the American Railway Master Mechanics' Association, the question of the technical education of railroad employees is treated in an interesting manner, and some valuable suggestions advanced. The present condition of railway operation especially, is set forth in a manner which shows very clearly the need for men of ability, character, and training to hold responsible positions.

"It is no small task properly to direct the design, to operate and maintain a thousand or more traveling power stations, such as modern locomotives have become, and to build up a policy and an organisation sufficient for such an undertaking on a single road, let alone doing this for a combination of roads. No other class of men in the world—without exception—is ever called upon to do what is everywhere expected of motive power officers, and the demands increase continually. The problem has grown perceptibly in two years and enormously in five.

"The problem is the selection, preparation and training of men. If this is provided for the rest is easy. It is said to be less difficult to secure a new president than to secure a good shop or roundhouse foreman. This is, of course, not true, but it certainly is sufficiently difficult to obtain the necessary supply of foremen of the right sort and even more difficult to secure the right kind of men in the ranks. The men are not essentially different from those of a generation ago, but the conditions certainly are different. To improve conditions it is necessary to know what is wrong, and to know what is wrong it is necessary to understand the changes which the last few years have brought.

"A few years ago railroad mileage was

computed in hundreds, whereas now it is measured in tens of thousands. The general manager once knew all of his subordinate officials, because they were few and changes were not frequent. He once knew all of his master mechanics, station agents, conductors, engineers, despatchers and even telegraph operators. They knew him and were working for him because he was personally close to them in their work. All this has changed as the roads themselves became greater and as roads great in themselves combined into systems, as has never been done anywhere else in the world. With this change the officers have by a powerful current been carried far from the men in the ranks and far even from their subordinate officials. From personal friends, the men have become to them as mere numbers."

The question of the expansion of a railroad organization is compared to that of an army, and it is shown that military methods are such that the size of an aggregation of men need not affect its efficiency or its strength. The commanding officer of an army cannot know all his men, but the captains do know theirs, and from this standpoint the railroads need more captains, because the subordinate officers now know their men as little as the chiefs know their subordinate officers.

"The recruiting of shop forces in the past was through apprenticeship. It is not so to-day. One of the best equipped railroad boiler shops in the country has not a single apprentice and few of them have enough to be worth mentioning. Of twelve trades in one shop plant only three were found to have apprentices, but all had shop committees. In other departments apprenticeship has been overlooked and neglected because there was so much else to do. There has been too much pressure to turn out work with existing facilities to admit of taking the necessary precautions concerning the men and the leaders of the future. The present demand for foremen with leadership talent and executive possibilities proves both the neglect of the apprentice and the distance which has grown between the officers and the men, for there certainly must be latent talent, dormant and undiscovered, sufficient for all necessities."

Formerly the ideal method of recruiting was found in apprenticeship. Apprenticeship, however, takes time, and the present pace does not admit of the continuance of a system which demands years for the acquisition of knowledge, which, under different methods and with proper preparation, may be effected in a much shorter time in a far more effective manner.

"For twenty years the railroads have sought to provide the necessary leadership from the technical colleges, and many strong officers have developed through what is known as the special apprentice system. It is perhaps possible to meet the immediate need in some such way; but when the technical school graduates come to the railroads, as outsiders, from the schools—as they usually do—this system is doing a fundamental injury, which is neither understood nor appreciated, but it is nevertheless serious. Every time a special apprentice is started on his course notice is, in effect, served upon the men and boys with whom he works, that he, because of his education, is to acquire in a few years sufficient knowledge, experience and ability to become one of the official staff. The effect in the shop is to discourage those who have not had such education. The special training of young men from without the ranks of the workers, for official positions, is fundamentally wrong, and, furthermore, it plays strongly into the hands of those who wish to see men leveled into classes, and considered as on uniform levels, as to the value of service. It may be necessary to continue special apprenticeship for a time. Technically educated men are needed and will be needed even more in the future, but they should come from the ranks and not from outside of the service. The present system, or any other system, which in any way serves to discourage the regular apprentices and thereby tends to cut off the source from which most of the successful men have come should give place to a system which will encourage all by making it possible for the lowest to become the highest in the briefest possible time, because the talent is needed now. Nothing adequately meeting the needs of American railroads has been accomplished either here or abroad. That such a system is possible and feasible can now be shown."

The method suggested by Mr. Basford is that of a revival of the old apprenticeship method, with an important, or even radical modification. The boys should be given the training in the shop, under such competent direction as will increase their earning capacity to the utmost, and consequently their value to their employers; and parallel with this shop training, instruction in a school provided and maintained by the road should be required. The school and the shop should be co-ordinate in every possible way, and the local officers must be interested in and responsible for the boys in the school as well as in the shop.

"As a part of the plan, every roundhouse should have a comfortable reading-room, provided by the company, with books, periodicals, charts and models. Every encouragement should be given the engineers and firemen to organize improvement clubs. The company should furnish stereopticons and occasional lecturers. Progressive education should accompany the present tendency toward progressive examinations. Here is another opportunity for university extension. Engineers and firemen should be educated to do their best, and it is important to bear in mind the fact that the difference between the work of the best and of the average man represents more to the road than the economies to be obtained from the best fuel-saving appliance or invention ever brought out."

Of course there are practical difficulties in the way of this plan, as, indeed, of any which can be advanced. Probably the most serious one is that of obtaining suitable instructors, and it is true that competent men for this kind of work are not plentiful, nor can they be had without proper compensation. Another difficulty is that of securing to the shop which has done the training the fruits of its enterprise. The old seven years' indenture was devised, partly for the training of the apprentice and partly to secure to the master some reasonable share of the young man's services after he had been trained. We have seen of late many instances of railroads acquiring the valuable services of men trained by rival roads, and there is no reason to believe that similar methods would not obtain with the rank and file which have been used higher up.

IRRIGATION IN EGYPT.

PROPOSED METHODS OF EXTENDING THE SCOPE OF THE WORKS FOR THE REGULATION OF THE NILE FLOODS.

Engineering.

WE have reviewed at various times in these columns the important engineering works constructed by the British government for the control of the flood waters of the Nile and for the redemption of vast areas of arable land in Egypt. That these works are by no means complete, is well understood, and the problems which are involved in their extension demand the highest engineering skill and the exercise of judgment and tact as well, in order to avoid political, financial, and sentimental difficulties. In a leading article published in a recent issue of *Engineering* the present state of the question is clearly set forth, together with some suggestions as to the correct procedure are made.

"The land of Egypt is unique in its physical conditions, as in its history. The cultivable soil of the country owes its origin entirely to the accumulated deposits of silt brought down annually by the Nile when in flood, and left on the land by the receding waters. Owing to the absence of rainfall in Egypt, the soil is entirely dependent upon these annual inundations both for water and for fertilisation; and any variation in the height of the river from the normal may cause widespread distress, and even famine—from drought or floods. The danger of this has been recognised from the earliest times. The ancient Egyptians attacked the problem with such success that 4,000 years ago the valley of the Nile supported a dense population, whose monuments stand to the present day among the wonders of the world. A civilisation capable of erecting the pyramids would be equally able to conceive and carry out the more important works for controlling the irrigation of the country, though it is only during the last two decades that the magnitude and character of these works have been realised by the modern world. Diodorus, Strabo, and Herodotus have independently borne witness to a vast artificial lake or reservoir, which was constructed to receive the superflous water from the Nile at flood time, and to distribute it when and where required by means of canals. The latter writer is enthusiastic in his admiration of the work, which he classes far above the mighty Pyramid of Cheops as an example of the triumph of human skill and labour over natural obstacles. This lake—Moeris—was dug by the orders of King Amenemhat III., who lived about 2000 B.C. It had a superficial area of 950 square miles—about the size of an average English county—with a depth in places of 300 ft., and its contour measured 450 miles. It was connected to the Nile by a canal ten miles long and 300 ft. wide, controlled by means of sluices, which served to draw off the surplus water from the river, and return it at periods of low water.

"As all who have followed the recent history of Egypt will know, the site of the ancient lake has been identified beyond doubt with the present province known as the Fayoum, by Mr. Cope Whitehouse, whose researches have not only abundantly justified the classical historians, but have had a most direct bearing upon the problem of the irrigation of Egypt at the present day. The canal to the Nile had become silted up during centuries of neglect, and the lake had vanished, but the depression remained, as a fertile valley in the desert."

When, in recent years, the control of Egypt was undertaken by Western nations it was seen that one of the most important things to be done was the regulation of the Nile and the control of irrigation by the construction of proper irrigation works. Attempts were made to reconstruct the barrage built at the apex of the Delta by the French in 1861, but this was seen to be insufficient, and hence the great dam at Assouan was designed and built, together with the regulating barrage at Assiout. So much has been written about these important works during and since their construction that details of the work need not be given here. Of more immediate interest is the answer to the question; what is next to be done? For it has become distinctly evident that these works, large and important though they are, are by no means adequate to accomplish the desired result. The irrigable area of Egypt is placed at six and a quarter million acres, and there is an ample supply of water in the Nile for the purpose, providing that the superfluous flood water is stored for use in the dry season. At the present time four million acres are perenially irrigated, and one-quarter of a million acres lying along the edge of the deserts must remain irrigated only in flood time, leaving the great area of two million acres yet to be dealt with. Since a storage capacity of two milliards of cubic metres of water are required for each million acres, so that the problem is that of providing reservoir capacity for four milliards of cubic metres of water. At its present level the reservoir formed by the dam at Assouan stores but one milliard of cubic metres, or only one-fourth of the required amount, leaving three milliards of cubic metres to be provided for.

In seeking for a reservoir for the supply of Egypt during the dry season, it is not to be wondered at that the reconstruction of the ancient Lake of Moeris should have been carefully considered. As, however, in the bed of the lake is a fertile province, with a cultivable area of 400,000 acres and a value of £80,000,000, its construction on its original site is out of the question; but there exists a smaller depression in the Libyan hills immediately to the south to which no such objections apply. This depression is known as the Wady Rayan, and Mr. Cope Whitehouse, the discoverer of Lake Moeris, has for years insisted that in turning the Wady Rayan into an artificial lake or reservoir lies the true solution of the problem of Egypt's water supply. Its area at a level of 29 metres above that of the sea would be about 700 square kilometres, or 270 square miles. When full, its greatest depth would be 70 metres, though only the upper four or five metres would be used annually, giving a possible supply of some three milliards of cubic metres out of a total contents of 20 milliards. Such a lake, however, would have one great drawback. Although during the month of April it would give a plentiful discharge, by the end of May its level would have so diminished that it could not give all that

Lower Egypt requires. By the middle of June it could not meet half the demand upon it for water, and a fortnight later it would be practically useless, as its level would have sunk approximately to that of the Nile. For this reason, by itself it would be inadequate, but, fortunately, we have at hand a means of contributing to the summer supply from another source. The Assouan reservoir, owing to its height, can be drawn from at any season of the year, and it is proposed by Sir W. Willcocks to raise the dam by six metres, making it the height originally intended, and use the water so stored to supplement the Wady Rayan discharge, thus maintaining a constant total discharge throughout the summer. The Assouan reservoir would, when raised, yield a supply of two milliards of cubic metres, and this would not be drawn upon until some time during May. As the summer came on the proportion of water from Assouan would increase, until in July it would be giving practically the whole supply. Working together in this manner the lake and the reservoir would provide the whole of the water needed for the irrigation of Egypt.

So far as the question of the strength of the dam is concerned, this has been agitated of late, especially in connection with the recent investigations of Messrs. Pearson and Atcherly, and the report of Sir Benjamin Baker. There appears to be little doubt that injurious scour has been produced upon the bed of the stream below the dam by the action of the discharge through the sluices, and for this reason, at least, the raising of the dam has been postponed.

The estimates of cost of the Wady Rayan scheme, according to Sir William Willcocks, amount to £2,600,000.

Mr. Cope Whitehouse, who first proposed the use of the Wady Rayan over twenty years ago, and who undoubtedly has a most intimate knowledge of the local topography, maintains that the entire work necessary can be done at a cost of £600,000. He has offered many times to undertake the contract for the work on the basis of this estimate, or to carry it out as a private speculation, subject to equitable terms of purchase by the Egyptian Government when completed. It is unfortunate that these offers had to be rejected, not because of any engineering reasons, but because the Government considered it preferable to leave a great part of Egypt unwatered rather than allow private enterprise to obtain command of any part of the national irrigation. However, whether it is to cost £600,000 or £2,600,000, the outlay will bring an enormous and immediate return, and the names of those who have assisted in bringing it to completion will deserve remembrance among the greatest benefactors of Egypt.

THE OSCILLATIONS OF RAILWAY VEHICLES.

CAUSES OF VIBRATION OF LOCOMOTIVES AND RAILWAY CARRIAGES AND METHODS OF REDUCING OSCILLATIONS.

Georges Marié—Académie des Sciences.

WITH the increasing demand for high speeds on railways it becomes necessary to investigate every possible cause of irregularity in motion, and perturbations which are negligible at moderate speeds may become of serious importance when trains are operated at rates of six to eighty miles an hour. Some of the causes of vibration in locomotives may undoubtedly be referred to the reciprocating parts of the engines, but there are other sources of irregularity. During the earlier experiments on the military railway between Marienfelde and Zossen, for example, much trouble was at first experienced from the oscillations of the cars, and yet these were driven by electric motors having only rotary movements, so that there was no reciprocating movement to be considered, and it was not until heavier rails and a more massive roadbed were provided that the higher speeds could be safely attained.

In papers recently presented before the French Academy by M. Georges Marié, and published in the *Comptes Rendus*, the various causes for the oscillation of railway vehicles are examined, and in view of the interest at present felt in the operation of high speed trains, some abstract of these papers is deemed opportune.

The vibratory action of steam locomotives has been studied for many years, and in nearly all cases the forces developed by the inertia of the reciprocating parts are modified by placing counter weights in the driving wheels. It is well understood, however, that such means are but partially effective, and in fact no disposition of revolving weights can wholly balance the action of reciprocating forces. It is also to be considered that the effort of the steam upon the pistons varies greatly during each stroke, and these variations are added to those of the reciprocating weights to produce vibrations. When it is considered how a stationary engine, even of moderate size and running at a medium speed, is carefully secured to a massive foundation, the difference in the case of a locomotive developing more than a thousand horse power, supported upon elastic springs, and propelling itself over an uneven roadway at a rate of 100 feet a second, may be appreciated.

The introduction of the four-cylinder balanced compound locomotive has enabled the disturbing action of the reciprocating parts to be materially diminished, but these are not entirely eliminated. To them must also be added the influence of the conical form of the tires, and the action of the steam in the cylinders as has already been seen.

All these, however, are but origins of vibrations, and in well designed engines they may be controlled as to be kept within practical limits at moderate speeds. At high speeds, however, they may give rise to serious and even dangerous oscillations. Thus, by carefully balancing, the perturbation due to any action of the machinery may be kept very small, considered at any one time. The periodical repetition of such an action, however, may cause a continual increase in amplitude until oscillations powerful enough to cause derailment may be reached. It is this increase in the amplitude of the oscillations, with increase in speed which is so important, and to this matter M. Marié gives especial attention.

In the case of a locomotive engine there is a tendency to develop an oscillation about a vertical axis passing through the centre of gravity, together with a horizontal oscillation of translation, besides a balancing action about longitudinal and transverse horizontal axes. It is most undesirable to have a synchronism existing between the period of oscillation of the locomotive and the revolutions of the driving wheels. For very high speeds it appears that the period of oscillation corresponds to about three complete revolutions of the drivers, and the experiments of M. Marié have shown that an odd synchronous relation of this sort is especially unfavourable.

Apparently the principal preventive of an increase in the amplitude of the oscillations lies in the damping effect of the friction of the various parts, such as the plates of the springs, the lateral friction of the bogie truck and of the tires. Even with the highest speeds at present employed it does not appear that the oscillations reach an amplitude rendering derailment probable. M. Marié points out, however, that care must be taken not to allow the damping action of the frictional resistances to be reduced too much, or an increase in oscillation may follow. The lateral oscillations of a locomotive may act to cause gradual spreading of the rails, this being in itself a serious cause of accident, and on roads on which high speed trains are operated, an especially careful watch should be kept by the track inspectors to detect such spreading action.

M. Marié is of opinion that a locomotive engine should not be made too rigid, but should rather possess sufficient elasticity to yield slightly in any direction, while at the same time opposing sufficient frictional resistance to retard any vibration so as to destroy any periodicity which might otherwise exist and develop existing oscillations.

There is no doubt that the question of the oscillation of railway rolling stock is a matter demanding the closest study and attention. Although vibrations are the primary cause of such oscillations it is the oscillations themselves, multiplying and increasing the vibratory effect, which constitute the danger. The lateral movement of the locomotive upon the track, causing the conical form of the tires to add its influence, may, at high speeds become sufficiently great to exert a most destructive action upon the track, and while the friction produced will dampen the oscillations the repetition of the action cannot fail to lead to disaster unless the effect is checked.

Railroad engineers have repeatedly maintained that the question of extremely high speeds is largely a matter of permanent way, and that with a sufficiently heavy track, well laid, and free from heavy grades and sharp curves, any reasonable speed may be maintained with existing locomotives. To this should be added the necessity of the closest inspection of the roadbed at all times, an especial watch being maintained to detect the particular deformations which may result from the repeated oscillations.

THE INFLUENCE OF STEAM JACKETS.

AN INVESTIGATION TO DETERMINE THE EFFECTS OF STEAM JACKETING UPON THE EFFICIENCY OF A HORIZONTAL COMPOUND STEAM ENGINE.

A. L. Mellanby—Institution of Mechanical Engineers.

NOTWITHSTANDING the numerous experiments which have been made to determine the influence of steam jackets upon steam-engine performance there still exists a difference of opinion among engineers, and the question is by no means yet regarded as settled. For this reason every intelligent investigation upon the actual behaviour of steam jackets is to be welcomed as aiding to determine a question of practical value. If there is little or no gain in the use of the jacket it should certainly be omitted, otherwise a needless cost and complication is added to the machine, but if there is any real advantage or economy to be effected by its use the jacket may well be retained. In a paper presented at the Liége meeting of the Institution of Mechanical Engineers by Mr. A. L. Mellanby some recent experiments made upon steam jackets at the Manchester Municipal School of Technology are described and discussed, and some points of interest brought out. Referring to previous investigations upon the same subject, Mr. Mellanby says that opinion has become somewhat settled on the following lines:

"(1) That jackets are useful for slow revolution, but not for quick-revolution engines.

"(2) That jackets are useful for simple and compound engines, but that their efficiency is doubtful, if they are applied to triple or quadruple expansion engines.

"It has long been obvious that there was considerable room for further experimental research upon this subject. The author therefore determined to take advantage of the opportunity which he had of carrying out tests upon the experimental engine at the Manchester School of Technology, to see whether some definite knowledge upon this important point could not be obtained.

"In most of the tests that have been published, it has been the custom to run a trial on any available engine that was fitted with jackets, and to find out the water used per indicated horse power per hour. This water would include the amount that entered the cylinder, and the amount that was condensed in the jackets. Another trial would then be made with the jackets shut off, and the consumption per indicated horse power per hour again measured. In some cases it has happened that the jacket steam has had the effect of reducing the engine-feed or increasing the horse power, and so improving the economy. In other cases it has happened that any reduced engine-feed or increased horse power has been more than counterbalanced by the extra steam used in the jackets. In the majority of the experiments published, the jacketed and unjacketed trials have been run at the same load, and no attempt has been made to find the best conditions for either case. The chief reason for this has been that the engines experimented upon were in actual service, and their load was fixed by the amount of work they had to do and not with regard to their best performance. Comparisons from such trials are of little scientific value, as it might easily happen if an engine were working at its most economical load for the jacketed conditions, the same would not be the most suitable when the jackets were off."

The engine upon which the tests were made was a horizontal cross-compound engine, 11½ inches by 20 inches by 24 inches stroke, the high-pressure cylinder being fitted with Corliss valves and the low-pressure cylinder with slide valves and Meyer cut-off plates. Both cylinders were jacketed on sides and heads, with separate supply pipes and valves, enabling either sides or heads to be cut out. The condensed jacket steam was drained off and measured in separate calibrated vessels. Full details and logs of the tests are given in the original paper, and the results graphically plotted in curves and tabulated for reference.

The effects of the jackets upon the performance of the engine are considered upon the power developed, and upon the steam consumption.

The use of jackets upon the high-pressure cylinder has the general effect of decreasing the mean effective pressure, and hence diminishing the horse power. The jacketing of the low-pressure cylinder has a different effect. The release pressure in the high-pressure cylinder is diminished to a slight extent, but the high-pressure back-pressure and the low-pressure admission-pressure are considerably increased. The low-pressure jackets therefore slightly lessen the steam in the high-pressure cylinder but to increase that passing through the low-pressure cylinder.

So far as steam consumption is concerned, the application of the jackets seems, as a general rule, to reduce the amount of steam passing through the cylinder of the engine. With only the high-pressure jackets on, the total steam per hour, namely, air-pump discharge and jacket steam, is less than when the engine is unjacketed. When the low-pressure jackets are applied, although the air-pump discharge is lessened, the total steam used is increased.

Mr. Mellanby gives especial attention to the so-called "missing quantity," or the difference between the indicated and the actual weight of steam passing through the cylinder. The experiments show that the indicated weight at release is in all cases greater than that at cut-off; that is, the missing quantity is less, or there is more steam shown to be present in the cylinder by the indicator at release than at cut-off.

"From an inspection of the curves of consumption, it would appear that if one wished to improve the economy of an engine, one ought to aim at reducing the missing quantity. In order to reduce this loss one ought to have a clear idea as to its cause, so that it may be known how best to apply the remedy. The necessity for a true explanation of this source of loss has long been obvious, and various theories have been brought forward by different writers and experimenters. The most commonly accepted explanation is that the cylinder walls are cooled by the out-going exhaust steam, that the incoming steam on meeting these cold walls is immediately condensed and fresh steam then passes in to supply the place of that condensed. A careful inspection of most text books reveals the fact, that it is the general opinion that the temperature of the cylinder walls follows that of the steam, and that at the end of release the walls are cooled down to the exhaust temperature. However, Professor Cotterill has pointed out that, if this were true, the missing quantity would be much greater than it usually is. He therefore inferred that the temperature range of the metal was less than that of the steam, and suggested that although the maximum temperature of the metal and steam would be probably the same, yet the minimum temperature of the metal was higher than that of the steam."

In investigating this same problem Messrs. Callendar and Nicolson showed that only a small proportion of the missing quantity was due to condensation, and they suggested that the greater part of the missing steam was due to direct leakage past the slide valve into the exhaust pipe. The steam jacket has an important influence upon this action as well as upon cylinder condensation, reducing the leakage as well as the condensation, this also agreeing with the experiments of Callendar and Nicolson.

There appears to be little doubt that the work of all recent experimenters on the steam engine demonstrates the presence of valve leakage to an important degree, and this point, as the principal source of loss in reciprocating engines, demands the attention of builders and designers alike both as to the type of valve adopted and the care given to its construction.

The following summary of results will be found of interest as containing the salient features of the researches of Mr. Mellanby:

(1) *Best mean pressure.*—That compound engines with a boiler pressure of 150 lbs. may be worked with a mean pressure referred to the low-pressure cylinder of about 40 lbs. per square inch without any loss of efficiency in terms of the brake horse-power.

(2) *Maximum efficiency.*—That the jackets have their maximum efficiency when the whole of the high-pressure and the ends of the low-pressure cylinders are jacketed with high-pressure steam.

(3) *Variation of indicated horse-power.*—That when the jackets are applied to the high-pressure cylinder the total indicated horse-power is slightly reduced, but when applied to the low-pressure cylinder the total indicated horse-power is considerably increased.

(4) *Initial condensation.* — That the jackets have little effect in the high-pressure but have a considerable effect in the low-pressure cylinder upon initial condensation.

(5) *Temperature-cycle of metal.*—That the temperature-cycle of the cylinder walls next to the steam must be considerably less than that of the steam.

- (*a*) Because the actual missing quantity is much less than it would have been had the steam and metal gone through the same temperature changes.
- (*b*) Because the mean temperature of the metal is higher than that of the steam.

(6) *Missing quantity.*—That the greater part of the 'missing quantity' must be due to leakage and not to initial condensation.

- (*a*) Because the application of the methods suggested by Callendar and Nicolson shows the condensation to be but a small fraction of the total missing quantity.
- (*b*) Because the apparent re-evaporation during expansion is less for jacketed than for unjacketed engines.

THE HEATING VALUE OF FUELS.

CALORIMETRIC METHODS FOR DETERMINING THE HEAT EVOLVED BY THE COMBUSTION OF ORGANIC SUBSTANCES.

H. Berthelot—Académie des Sciences.

THE term calorimeter has unfortunately been applied to several entirely different objects in connection with engineering work, and sometimes it is possible to determine which is meant only by a careful examination of the context. The old usage of the word to mean the collective sectional area of the flues in a boiler, is happily almost obsolete; but the use of the word to mean both an apparatus for determining the heating value of a fuel and a device for measuring the percentage of moisture in steam seem, unfortunately, to be too firmly established to permit of a change. The former use of the word is certainly the most logical, and it is of the fuel calorimeter that M. Berthelot speaks in a paper presented by him to the French Academy from which we make some abstract. The actual systematization of the method of measuring the calorific power of fuels was largely due to the work of M. Berthelot himself, he having demonstrated, as long ago as 1865, that the thermal value of a substance could be accurately computed from the heating power of its constituents, and hence his review of the subject, in a recent issue of *Comptes Rendus* possesses an especial value.

The earliest attempts to measure the heat value of a combustible were made by Lavoisier, who burned the substance in an atmosphere of oxygen, under atmospheric pressure, and from these crude experiments followed the work of Dulong, Andrews, Favre and Silbermann, and their successors. Experience has shown, however, that the direct combustion in this manner is accompanied with many difficulties, owing to the impracticability of insuring complete combustion, and the uncertainties in the determination of weights and temperatures. Various delicate corrections are necessary in order to eliminate error, so that there are many opportunities for the precision of the result to be impaired.

M. Berthelot examines at length the extensive investigations which have been made by Thomsen, using the old method of combustion at atmospheric pressure, and shows that with all the care and ability which this able experimenter has brought to the work the results are in serious error in several instances. This being the case, it is hardly to be expected that the method can be found of practical utility in the hands of ordinary operators.

In order to avoid the errors which appear to be inseparably connected with the earlier methods, M. Berthelot devised the so-called calorimetric bomb, and with this apparatus he has succeeded in eliminating the principal sources of error. The fundamental principle involved in the bomb is that integral transformation of the substance shall be completely and definitely effected in an almost instantaneous manner, entirely within the calorimeter, thus reducing all the corrections to an extremely small fraction of the total heat measured. By employing pure oxygen under a high pressure this result has been accomplished, the ignition being effected by electricity, and the whole operation completed in the shortest possible time.

Insisting upon the necessity for eliminating the serious sources of error which creep in when the combustion is conducted for a considerable length of time, and at or near atmospheric pressure, M. Berthelot criticises rather severely the work of Thomsen, being moved thereto, doubtless by some recent comments of the German savant upon the results obtained by investigations in France. Regardless of any question of personal feeling in the matter, there appears to be little doubt of the superiority of the method devised by Berthelot, and modified by Mahler and others only in the direction of reduction of cost and increase in convenience, without material modification in principle. Engineers have learned very definitely that complete combustion can be promptly effected under pressure, while it is exceedingly difficult to insure the entire combustion of a determinate quantity of a fuel, even in the presence of oxygen, at atmospheric pressure. The time element is also an important one, and any quantitative method depending upon precise readings of delicate thermometers before and after a combustion, must certainly have the possibility of error greatly minimised by a reduction in the time of the whole operation.

It is interesting to note that in the recent tests of the heating values of American coals, made at the St. Louis Exposition under the auspices of the United States Geological Survey, the calorific values were determined by the Mahler bomb calorimeter, this being identical with the Berthelot calorimeter in principle and action, the modifications in design being made solely for the purpose of reducing the cost.

HIGH-SPEED ELECTRIC TRACTION.

A REVIEW OF THE WORK OF THE RESEARCH COMMITTEE UPON THE MARIENFELDE-ZOSSEN ELECTRIC RAILWAY.

Charles A. Mudge—New York Electrical Society.

WE have reviewed at length in these pages the remarkable results which have been attained with electric traction upon the military railway between Marienfelde and Zossen, near Berlin, and a fully illustrated paper upon the subject by Dr. Alfred Gradenwitz has also been published in this magazine. Since those experiments the work of investigation has been continued by a special research committee, and much interesting information has been gained about high-speed electric traction, as well as high railway speeds in general. In the course of a lecture delivered before the New York Electrical Society, Mr. Charles A. Mudge, who has taken part in some of these tests, discussed the work which has thus far been done, and an abstract of these valuable investigations is here given from this address:

"The objects of the tests were to make a study of many of the heretofore incompletely, and in some cases, wholly unknown factors entering into electric traction at speeds never before attempted, such as collecting current at high voltages, traction and air resistances, best design of trolleys, motors, transformers, brake gears and trucks, the power required to run at high speeds, the details entering into the construction of the permanent way and the collection of other data in order to calculate costs of future installations."

The construction of the road and the rolling stock has already been fully described, and it is necessary here only to repeat that the road is about fourteen and a half miles long, with but two curves, each of one and a quarter miles' radius, there being no grades. Allowing four miles at each end for acceleration, there remained a run of seven miles upon which the actual high-speed runs were made. The power was supplied in the form of three-phase current at about 14,000 volts in the car, the car weighing about 100 tons complete, and during the high-speed tests it was successfully run at speeds of 125 to 131 miles per hour. Among the important elements investigated by the research committee were those involving train resistance at different loads and speeds and the necessary data for use in braking. Investigations upon air resistance were also made, and valuable data determined. Referring to the earlier trials, in the autumn of 1902, Mr. Mudge said:

"These tests were conducted up to a speed of only seventy-five miles per hour, as the observations of the previous year showed that the permanent way would not stand much higher speeds. To determine the train resistance as well as the energy absorbed in running the car a distance of four miles, starting at the car barn, was very carefully measured, and all curves, grades and levels were absolutely fixed. This made it possible to correct the observed data so accurately that the recorded results in this year's report are of the greatest value.

"The brake tests made in this year were not as satisfactory as those in the following year, on account of the complicated brake rigging used, which did not allow of easy adjustment, and which I will not therefore attempt to analyze.

"Suffice to say, that the maximum retardation of two miles per hour per second was recorded at seventy miles per hour, with a total brake pressure equal to 155 per cent. of the weight of the car. At the conclusion of the tests this year it was found necessary to build new trucks with a two-foot longer wheel base, and to support the car body on the truck frame at some distance from the centre pin. Also to flexibly support the centre pin in the truck, thereby allowing the car body to have a movement of about one inch on each side of the truck centre independent of it, and in a line at right angles to the track. In order to observe the action of the springs and their connecting levers, it was decided to place them on the outside of the frame of the truck. The tests this year were of value in showing what alterations in the car and permanent way were necessary in order to be able to run at higher speeds.

"Data of very great value were secured on the much discussed question of air resistance, and although the formula may not be straightened out to suit everybody, we know positively that if we run our car, for instance, fifty miles per hour we can expect a maxmum air pressure of about seven pounds per square foot at the front of it; and if we double the speed we will get four times this pressure, and if we triple the speed we will run into trouble and get nine times this pressure. If we shape the nose of our car properly we will be able to reduce these figures ten per cent. Also if we run our 100-ton car fifty miles per hour on a level track without paying much attention how the front of it is shaped, it will take about 150 horse-power. When we double the speed it will take six times this amount of power; but if we attempt to triple the speed, i. e., to run at 150 miles per hour, we would have to supply about eighteen times the amount of power it takes to run at fifty miles per hour."

It is well known that an important element in successful high-speed operation on steam railways is the character and condition of the track and roadbed. In view of the absence of reciprocating parts in the electric machinery on the cars it might be supposed that an extremely heavy track would not be as essential with electric traction as with steam locomotives. It was found, however, that much of the vibration and oscillation was due to the roadbed, and this was made a point for study. In addition it was thought advisable to use improved trucks with greater wheel base. The experiments made after these improvements were carried out showed very satisfactory results. This was due, not only to the better designed trucks, but also to the excellent service given by the new track, consisting of rails of 82½ pounds weight, with closer spaced cross ties, and more substantial ballast. With the lighter track there was a marked oscillation produced when it was attempted to run the car faster than 100 miles an hour, a swinging lateral motion being produced which threatened to endanger the overhead work. This was found to be due to the unsymmetrical disposition of the motors and transformers on the car, and it was counteracted by placing weights along the floor of the car, in such positions as to oppose the periodic oscillation.

So far as braking is concerned, it has been found that very high brake pressures are required to give a comparatively low retardation. Thus, it was found that about seven-eighths of a mile was required to stop the car when running at 110 miles an hour, the initial brake pressure being 150 per cent. of the weight of the car.

"Basing our ideas upon some of the observations and experiences gained in these tests, we would make use of the following points in approaching a similar railway problem:

"Keep the car body as near the rails as possible.

"Arrange all heavy pieces of apparatus so that their centres of gravity lie in the centre of the car, or symmetrically placed to it, and as near the earth as possible.

"All apparatus mounted above the car floor should be as light as their design will permit.

"Make the overhead trolley contact above the car, in preference to the side of the car.

"Support the motors flexibly on the axles of the trucks.

"Give the front end of the car a wedge shape.

"Support the car body to the truck frame at some distance from the centre bolt, and allow it a flexibility in a line at right angles to the track, independent of the truck.

"Make the total wheel base of the truck of ample dimensions, and not less than twenty per cent. of the length of the car.

"Build the road as straight as possible, and where more than one track is used make them further apart than our present practice would suggest.

"On curves, make the approaches of the elevated side of the track longer than usual.

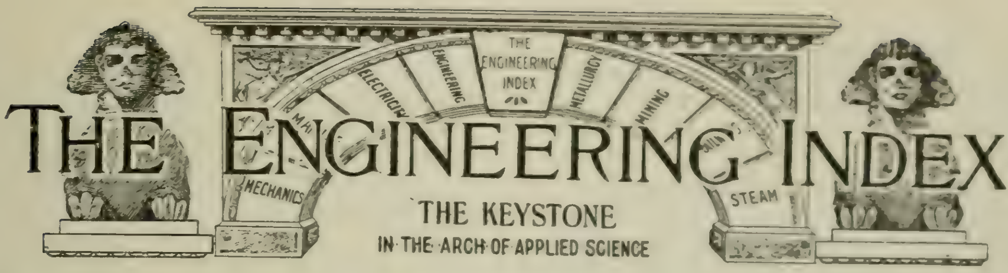
"In providing for curves at these high speeds it has been found important to allow the car body to be permited a certain amount of lateral movement on the trucks. The trucks take curves much more quickly than the heavy car body, and a certain amount of time is required to swing it out of its straight-line path. By mounting the centre-pin bearing flexibly in the truck the car body is swung more gradually into the direction taken by the trucks, and the shock is materially lessened.

"The question of signalling high-speed trains is a matter demanding serious consideration.

"In passing stations at 125 miles per hour it was not possible to recognize persons standing upon the platforms, and only those at a distance of fifty feet and over could be approximately identified. On dark and rainy days it was quite impossible to read signals at this speed, except when of large dimensions or of very pronounced color.

"This would suggest placing the signals in the car itself, operated electrically, either by direct contact or through inductive means. Such a system was tried at Zossen and worked perfectly, even at the highest speeds.

"In all the runs, of which over 300 were made, no difficulties were met with, or even suggested, that the skill of the engineer did not or could not overcome, and this great triumph, in a branch of industry which has done more than any other to lift the human race to a higher degree of intelligence, should serve as a stimulus to us, who are anxious to have trains in regular service running at this, the highest speed ever attained by any device used for human transportation, 131 miles an hour."



THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Austerlitz.

The Double-Track Austerlitz Bridge, Paris. Illustrated description of an arch bridge across the Seine, with a suspended floor of peculiar construction. 2200 w. Eng Rec—June 24, 1905. No. 70385.

Cantilever.

The Cantilever Erection of the St. Joseph Drawbridge. An illustrated account of this work, with an explanation of the difficulties encountered in erecting the east arm of the draw span. 1500 w. Eng Rec—June 3, 1905. No. 70058.

Concrete Arch.

The Connecticut Avenue Concrete Arch Bridge at Washington, D. C. Illustrated description of the structure and methods of construction. 3000 w. Eng News—June 1, 1905. No. 70038.

Concrete.

Concrete Bridge Over the Big Muddy

River. Illinois Central Railroad. Illustrated detailed description of the new bridge at Carbondale, Ill., consisting of three elliptical arches, and built almost entirely of concrete. 1800 w. Sci Am Sup—June 17, 1905. No. 70242.

Draw-Bridge Wreck.

Wreck of the Portage Canal Draw-Bridge. A detailed account of the accident at Houghton, Mich., with illustrations, and of the clearing of the channel. 1000 w. Eng News—June 1, 1905. No. 70042.

Floors.

Ballasted Bridge Floors. A. F. Robinson. Gives illustrations and information of work in Great Britain and America, with remarks on the various types. General discussion follows. 14000 w. Jour W Soc of Engs—June, 1905. No. 70526 D.

Fraser River.

The New Westminister Bridge Over the Fraser River, British Columbia. Illustrated detailed description of this double-deck railway and highway structure, and its construction. 2500 w. Eng News—June 15, 1905. No. 70234.

The New Westminster Bridge Over the Fraser River, British Columbia. Illustrates and describes the superstructure, notable for the special "spread" span designed to accommodate a Y-track, and for the methods of erection. 2000 w. Eng News—June 22, 1905. No. 70346.

Highway Bridge.

The Highway Bridge Over the Wabash River at Terre Haute. Illustrated description of a structure having an unusual combination of trusses and plate girders. 2000 w. Eng Rec—June 17, 1905. No. 70291.

Nile.

The New Bridge over the Nile at Cairo (Die Neuen Nilbrücken in Kairo) Josef Rosshändler. Discussing the plans for the proposed highway bridge, witn details of the various projects submitted. 2500 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—May 26, 1905. No. 70443 D.

Plate Girder.

Plate Girder Bridge with Pile Bents. G. S. Crites. Illustrates and describes a design used on the Southern Pacific in certain places, which seems to eliminate the danger of blocking streams, and fills all demands. 1500 w. Cal Jour of Tech —May, 1905. No. 70325 C.

Reinforced Concrete.

Grand River Reinforced Concrete Bridge, Grand Rapids, Mich. Information concerning the design and construction as given in a paper before the Michigan Engng. Soc., bv P. M. Louwerse. 1200 w. Eng Rec—June 17, 1905. No. 70293.

Swing Bridge.

The St. Louis Southwestern Bridge at Shreveport, La. Illustrated detailed description of a bridge with swing span, the total length of the bridge being 1265 ft. 800 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70265.

Thebes.

The Thebes Bridge. Ralph Mojeski. An illustrated description of the location, design, and construction, discussing the considerations which led to the design as adopted. 6000 w. Trans Assn of Civ Eng of Cornell Univ—1905. No. 70538 F.

Transporter.

Widnes and Runcorn Transporter Bridge. Illustrated description of the bridge and its operation. 1300 w. Elec Engr, Lond—June 16, 1905. No. 70503 A.

Viaducts.

Caledonian Railway New Viaducts and Extensions. Illustrates and describes engineering features of interest, especially the erection of two viaducts over the river Avon, one of which is 175 feet above the bed of the river. 2800 w. Engr, Lond—June 9, 1905. No. 70310 A.

Reconstruction of the Horse Run Viaduct: Cincinnati Southern Railway. Illustrated description of the rebuilding, without interrupting traffic, of this bridge at Ludlow, Ky. 2000 w. Eng News—June 8, 1905. No. 70100.

The Fades Viaduct Over the Sioule River near Vauriat, France. Illustrated description of a continuous structure, a three-span girder of deck type, having two multiple-web trusses. The center is 435 ft. above the bed of the river, and masonry piers are used instead of steel towers. 1800 w. Eng News—June 8, 1905. No. 70094.

The Syra Valley Bridge at Plauen (in Vogtland). Herr Fleck. Illustrated detailed description of this stone viaduct. The arch has a span of 295 feet between abutments. 2700 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70542 F.

Zambezi.

The Bridge over the Zambezi (Le Pont sur le Zambéze). A description of the Falls of the Zambezi and the construction of the railway bridge over the gorge below the falls. 1500 w. Génie Civil—June 3, 1905. No. 70426 D.

CONSTRUCTION.

Arch Roof.

Three-Hinged Arch Roof of the New 69th Regiment Armory, New York City. Gives drawings of the framing, with description. 2000 w. Eng News—June 1, 1905. No. 70037.

Armory.

The Sixty-ninth Regiment Armory Drill Hall, New York. Illustrated detailed description of a fine drill hall 201 ft. 11½ in. long and about 188 ft. 10 in. wide, and nearly 130 feet in extreme height. 3900 w. Eng Rec—June 3, 1905. No. 70053.

Beams.

Notes on the Strength of Beams, Plates and Columns. R. P. King. An explanation of a method using the moment of resistance. 1500 w. Mach, N Y—June, 1905. No. 70003 C.

Buckling.

Tests upon the Buckling Resistance of Pillars with Fixed Ends (Ergebnisse von Versuchen über die Knickfestigkeit von Säulen mit Fest Eingespannten Enden). Prof. B. Kirseh. Data and tabulated results of tests upon round pillars of wrought iron under longitudinal pressure. 4000 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70408 D.

Building Construction.

The Candler Building, Atlanta. Illustrated detailed description of a 17-story steel-cage office building. 1500 w. Eng Rec—June 17, 1905. No. 70296.

The Mutual Life Building in the City of Mexico. Brief illustrated description of a modern office building costing $1,500,000. The treacherous soil made it necessary to float the building on a mattrass of concrete and steel grillages. 1500 w. Eng Rec—June 10, 1905. No. 70182.

The Rebuilding of a Theatre at Buenos Ayres (Reconstruction d'un Theatre à Buenos Ayres). An illustrated account of the manner in which a large theatre was wholly rebuilt without interrupting the daily performances. 1000 w. Génie Civil—May 13, 1905. No. 70420 D.

Chimneys.

Chimney Shafts. An illustrated article discussing the repair, straightening, raising and felling of chimneys. 2200 w. Public Works—April, 1905. No. 69930 F.

Columns.

Results of Comparative Tests of Plain and Reinforced Concrete Columns. E. J. McCaustland. A record of tests made to determine the behavior of concrete and steel in combination. 1200 w. Eng News—June 15, 1905. No. 70235.

Concrete.

Description of the Concrete Residence at Port Antonio, Jamaica Islands. E. S. Larned. Ills. Also gives particulars of the construction. 2500 w. Cement Age—June, 1905. No. 70388.

Dams.

Masonry Dam for the Granite Springs Reservoir, Cheyenne, Wyo. A. J. Wiley. An illustrated article explaining conditions at Cheyenne, and describing this dam and the methods of construction and appliances. 4800 w. Eng Rec—June 24, 1905. No. 70378.

Masonry Dam for the Granite Springs Reservoir, Cheyenne Water-Works. A. J. Wiley. Slightly condensed from the author's report to the city of Cheyenne, Wyo. Illustrated detailed description of this dam, the methods of construction, and conditions. 5500 w. Eng News—June 29, 1905. No. 70536.

Memorandum *in re* Arched Concrete Dam at Barossa, South Australia. Alex. B. Moncrieff. An illustrated article especially dealing with the details of the concrete used in the construction. 2500 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70544 F.

The Assuan Dam. Reports an interview with Sir William Willcocks, discussing the difficulties due to erosion, and other matters relating to the design. 1200 w. Engr Lond—June 9, 1905. No. 70311 A.

Dry Docks.

See Marine Engineering.

Fire Protection.

Fire Protecting Coverings for Window and Door Openings. Abstract of a committee report presented at meeting of the Nat. Fire Pro. Assn. Opinions in regard to materials in use, with suggestions. 1000 w. Eng News—June 1, 1905. No. 70039.

Specifications for the Construction of Inside Oil Rooms. Report to the Nat. Fire Pro. Assn. concerning rooms for holding the daily supply of oils, paints, varnishes, etc. 1200 w. Eng News—June 1, 1905. No. 70040.

Hippodrome.

The New York Hippodrome. Harry D. Gue. Discusses the structural and protective features of this large amusement building. 2000 w. Ins Engng—June, 1905. No. 70320 C.

Inverted Siphon.

The Morris Canal Crossing of the Lackawanna R. R. Brief illustrated description of the unusual methods adopted to maintain traffic in the canal during the work of depressing the tracks of this road, and the building of an inverted siphon. 1100 w. Eng Rec—June 17, 1905. No. 70295.

Masonry.

Notes on Stone Masonry. Charles Arthur Hague. A discussion of stone masonry work and methods of adjusting cost and conditions. 3500 w. Cassier's Mag—June, 1905. No. 69968 B.

Reconstruction.

The Reconstruction of the Continental

Trust Building, Baltimore. Describes this sixteen-story steel-cage office building as first constructed, the damage wrought by the great fire, and the method and extent of reconstruction. Ills. 2500 w. Eng Rec—June 3, 1905. No. 70056.

Reinforced Concrete.

Expansion and Contraction Cracks in a Reinforced-Concrete Structure. George W. Blodgett. Detailed description of the buildings of the United Shoe Machinery Co., at Beverly, Mass., with report of the cracks, especially in the floors, and the method of making repairs. Ills. 2200 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70262.

Reinforced Concrete Warehouse for North-west Knitting Co., Minneapolis, Minn. Drawings and description of building with novel features. 900 w. Eng News—June 8, 1905. No. 70098.

Reinforced Concrete Stable. Illustration and brief description of a stable at Scarsdale, N. Y. 1500 w. Eng Rec—June 10, 1905. No. 70181.

The Harrison Building. Cliff M. Stegner. Illustrated description of an eight story reinforced concrete skeleton building being erected in Cincinnati, O. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70546 F.

See also Civil Engineering, Bridges, and Materials of Construction.

Simplon.

The Simplon Tunnel. Lewis A. Parsons. Brief review of the work. 2000 w. Yale Sci M—June, 1905. No. 70299 C.

Warehouse.

The Ryerson Structural Steel Warehouse. Illustrated description of the enlarged plant on Sixteenth street, Chicago. 2000 w. Ir Age—June 1, 1905. No. 69959.

Wharf.

See Civil Engineering, Waterways and Harbors.

MATERIALS OF CONSTRUCTION.

Asphalt.

Asphalt and Bituminous Rock Deposits of the United States. Abstract by Prof. Arthur Lakes, from the U. S. Geological Survey. Describes the nature of the material and forms of veins. Ills. 3300 w. Mines & Min—June, 1905. No. 70077 C.

Brick.

Silica Coke-Oven Brick. Discusses their action on heating and cooling, comparing their wearing and heat-resisting qualities with those of clay brick. 1600 w. Mines & Min—June, 1905. No. 70078 C.

Building Stone.

Stone Quarries on the Coast. Report of H. Carmichael concerning the large quantities of good building stone along the coast and islands of British Columbia. 2000 w. B C Min Rec—May, 1905. No. 69956 B.

Tests on Texas Building Stones. William B. Phillips. Gives results of experiments with certain building stones of Texas, carried out by the University of Texas Mineral Survey, during the last two years. Ills. 3500 w. Min Wld—June 24, 1905. No. 70369.

Cement.

Tests of Cement at the Watertown Arsenal. James E. Howard. A report covering tests made during the past four years. 4800 w. Cement Age—June, 1905. No. 70390.

The Cement Resources of Alabama. Samuel H. Lea. Reports an almost inexhaustible supply of materials suitable for Portland cement, discussing the economic advantages they possess. Map. 2500 w. Mines & Min—June, 1905. No. 70076 C.

The Grinding of Portland Cement. George M. Newcomer. A study of the problem of grinding. 4500 w. Cement Age—June, 1905. No. 70389.

Concrete.

Some Recent Tests of Concrete in Tension and Compression at the Columbia University Laboratories. Ira H. Woolson. Gives results of tests made for the Astoria Light, Heat & Power Co. Ills. 3500 w. Eng News—June 1, 1905. No. 70036.

The Strength of Concrete. Sanford E. Thompson. A study of the practical tests that have been made on plain concrete and the laws that seem to govern the strength, giving much information of value. General discussion. 15800 w. Jour Assn of Engng Soc's—April, 1905. No. 70532 C.

See also Reinforced Concrete, below.

See also Civil Engineering, Construction.

Lime.

The Use of Hydrated Lime. Explanation of the properties of hydrated lime, as given in a paper by E. W. Lazell, before the Nat. Lime Mfrs. Assn. 1600 w. Eng Rec—June 3, 1905. No. 70059.

Reinforced Concrete.

The Frictional Resistance of Iron in Concrete (Versuche über den Gleitwiderstand Einbetonierten Eisens). C. Bach. Data and results of tests to determine the force required to cause reinforcing rods of various sections to slip in concrete mass. 1200 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70412 D.

The Strength of Reinforced Concrete. T. L. Condron. A comparative study of recent scientifically conducted tests of reinforced concrete beams. Discussion. 10800 w. Jour W Soc of Engrs—June, 1905. No. 70529 D.

See also Railway Engineering, Permanent Way and Buildings.

Sand.

The White Sands of New Mexico. Frank W. Brady. An illustrated description of a remarkable formation of nearly pure gypsum sand. 2000 w. Mines & Min—June, 1905. No. 70075 C.

Stone Work.

Decay and Preservation of Stone-Work. W. R. Purchase. Remarks on the causes of decay and what may be done toward diminishing their effects. 2500 w. Builder—June 17, 1905. Serial. 1st part. No. 70395 A.

Timber Preservation.

The Preservation of Timber with Antiseptics. E. H. Bowser. An explanation of the methods in use, especially the present method of creosoting as applied in the United States. 5000 w. Jour Assn of Engng Soc's—April, 1905. No. 70531 C.

MUNICIPAL.

Florence.

The Public Works of Florence. Cav. A. G. Linari. A brief review of municipal engineering in Florence, where great improvements have been made in recent years. 4000 w. Public Works—April, 1905. No. 69931 F.

Manila.

Present and Prospective Sanitation of Manila. O. L. Ingalls. An account of the method of waste disposal previous to American occupation and description of the sewerage system installed. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70547 F.

Parks.

The Park System of Metropolitan Boston. William T. Pierce. An illustrated article outlining the work of the Metropolitan Park Commission. Also some of the local and district parks are considered. 5800 w. Public Works—April, 1905. No. 69926 F.

Pavements.

Brick Pavement Specifications. Gives a specification designed to carry out the ideas of the writer, with remarks. 1600 w. Munic Engng—June, 1905. No. 69987 C.

Sewage.

Extensions of the Worcester Sewage Disposal Works. Illustrates and describes these works, which are the largest in the United States, and probably marked by the greatest variety of methods. The sewage is of peculiar character due to the presence of iron salts from wire mills. 2500 w. Eng Rec—June 24, 1905. No 70383.

Sewage Disposal Works at Chichester. James Saunders. Gives the early history of early sanitary conditions in this old Roman city and an illustrated description of the new sewage disposal works. 3500 w. Public Works—April, 1905. No. 69928 F.

Sewage Purification Plant at Charlotte, N. C. Cecil C. E. Beddoes. A report of the working of an economical plant. Ills. 1800 w. Eng Rec—June 24, 1905. No. 70382.

Sewerage.

A Failure of the Waring Small-Pipe Sewage System. Full decision of Judge Letton, of the Supreme Court, of Nebraska, in the case of Shannon v. City of Omaha. 1600 w. Eng Rec—June 3, 1905. No. 70057.

Sewer Construction in St. Louis. Curtis Hill. Illustrates and describes interesting features of the sewer construction, the "combined system" being the method used. 3000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70539 F.

WATER SUPPLY.

Analysis.

The Field Assay of Water. M. O. Leighton. Explanatory remarks with methods for determining the turbidity, color, total hardness, alkali carbonates, normal carbonates, bicarbonates, total sulphates, chlorine, iron, and calcium. 7000 w. Eng News—June 8, 1905. No. 70095.

Artesian Wells.

Deep Wells as a Source of Water Supply for Minneapolis. N. H. Winchell. Shows that there are several water basins below this city which will give an inexhaustible supply at moderate cost. Drawings. 9300 w. Am Geol—May, 1903 No. 70026 D.

Dams.

See Civil Engineering, Construction

Danville, Ill.

Recent Improvements in the Plant of the Danville Water Company. Daniel W. Meal. Reviews the history of the water-supply of Danville and gives an illustrated description of the plant, the new dam, mechanical filters, etc. Discussion. 7000 w. Jour W Soc of Engrs—June, 1905. No. 70527 D.

Filtration.

Filtration System for Pittsburg. Howard W. Underwood. An illustrated detailed description of the novel features of this system, now under construction. The plant is equal in area to the largest plant in the world. 6500 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70543 F.

Mechanical Filter at Binghamton, N. Y. George C. Whipple. Illustrated detailed description. 1500 w. Eng Rec—June 17, 1905. No. 70294.

The Management of the Roxborough Water Filters, Philadelphia. Explanation of their management reprinted from a report by John W. Hill. Ills. 2200 w. Eng Rec—June 24, 1905. No. 70379.

Fire Service.

High-Pressure System for Fire Service. Report of Committee of National Fire Protective Assn. Recommends their introduction for certain places, discussing their requirements. 5200 w. Eng Rec—June 3, 1905. No. 70055.

Intakes.

Water Supply Intakes. Herbert E. Bellamy. Discusses particularly those rivers which are liable to large floods and where pumping is necessary. Considers the site of the intake, design, tunnel, etc. Ills. 1000 w. Public Works—April, 1905. No. 69925 F.

Irrigation.

Irrigation Survey of the Upper Snake River Valley, Idaho. E. B. Darlington. Review of the statistics obtained from investigations on a large scale, describing the work done. 1000 w. Eng News—June 1, 1905. No. 70041.

The Irrigation of Egypt. A brief review of the work already accomplished and discussion of proposed work in the valley of the Nile. 3000 w. Engng—June 16, 1905. No. 70510 A.

Pressure Gage.

The Measurement of Low Artesian Heads. Myron L. Fuller. Describes a small, handy gage for taking artesian well pressures, which can be carried in the vest pocket. 700 w. Eng News—June 8, 1905. No. 70097.

Purification.

Water Purification. D. J. Russell Duncan. Read before the Engrs' Club of Toronto. Brief references to various methods, with suggestions for the application of practical processes, economical in operation and maintenance. 4500 w. Can Engr—June, 1905. No. 70127.

Reservoirs.

A Great Indian Reservoir. R. B. Buckley. An illustrated description of the Marikanave reservoir, in Mysore, now approaching completion, which will be the largest in India. 2000 w. Public Works—April, 1905. No. 69929 F.

Ring-Braced Sheet Piling for Reservoir Construction, Kinston, N. C. George A. Rogers. Illustrates and describes the method of using ring-bracing for holding sheet-piling in place while building a circular reservoir. 500 w. Eng News—June 15, 1905. No. 70237.

The Wachusett Reservoir for Boston Water Supply. Illustrated description of this great engineering work, storing 63,000,000,000 gallons. 1300 w. Sci Am—July 1, 1905. No. 70550.

Screens.

Mechanically Operated Screens, Newark Water-Works. Illustrated detailed description of the novel manner of handling these metal framed screens, as given in a paper by J. Ralph Van Duyne. 600 w. Eng Rec—June 3, 1905. No. 70054.

Water-Works.

Ilkeston and Heanor Water-Works. George and F. W. Hodson. Details and illustrations of a very complete waterworks undertaking. 6400 w. Public Works—April, 1905. No. 69933 F.

WATERWAYS AND HARBORS.

Dams.

See Civil Engineering, Construction.

Debris Barrier.

Débris Barrier No. 1, Yuba River, Cal. Illustration, with brief description of structure now being built for holding and storing mine débris in the river. 1000 w. Eng News—June 15, 1905. No. 70232.

Flow.

Flow over a Weir of Curved Profile (Der Abfluss an Einem Grundwehre Kurvenförmigen Profils). Johann Hermanek. A mathematical investigation, discussing the influence of the section of a weir upon the discharge. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—June 2, 1905. No. 70445 D.

Harbor Cableways.

The Provision of Harbor Facilities on Difficult Coasts by Means of Cableways (Die Schaffung von Landungsstellen an sonst Unzüganglichen Küsten mittels Schwebender Transporteinrichtungen). G. Dieterich. Describing the use of a cableway, carried on a cantilever pier for handling cargo, off difficult coasts. Serial. Part I. 2500 w. 1 plate. Glasers Annalen—June 1, 1905. No. 70440 D.

Harbor Works.

Dover Harbor Works. A. T. Walmisley. Reviews what is known of the early history of the harbor, and gives an illustrated description of the recent improvements, the appliances used, the construction work, etc. 10000 w. Public Works—April, 1905. No. 69927 F.

The Bruges Harbor Works. An illustrated description of the works at Zeebrugge, the outer harbor of the maritime canal connecting Bruges with the North Sea. 3300 w. Engng—May 26, 1905. Serial. 1st part. No. 70117 A.

Jetties.

The Southwest Pass Jetties. H. W. Parkhurst. Gives general description and specifications of work contemplated at New Orleans for the improvement of navigation. Ills. 4000 w. R R Gaz—Vol. XXVIII., No. 24. No. 70266.

Mississippi.

The Mississippi: Controlling Floods, Navigation Improvements. H. Van Meerten. A continuation of the Haupt-Van Meerten discussion. Ills. 5500 w. Jour Fr Inst—June, 1905. No. 70218 D.

Panama Canal.

History and Present Status of the Panama Canal. With illustrations and editorial on the alternative plans for the canal. 3600 w. Sci Am—June 3, 1905. No. 69993.

The Panama Canal (Le Canal de Panama). A. Dumas. An illustrated historical account of the two French companies and of the sale of the concession and works to the United States government. Three articles. 7500 w. Génie Civil—May 6, 13, 20, 1905. No. 70419 each D.

The Panama Canal. Six relief model maps showing the six plans that have been considered for this great undertaking. 1200 w. Marine Engng—June, 1905. No. 70016 C.

The Problem of the Panama Canal. Lindon W. Bates. A brief review of the plans and a discussion of the problems, explaining the terminal lake plan, proposed by the writer. Map. 2500 w. Yale Sci M—June, 1905. No. 70298 C.

Wharf.

A Fireproof Wharf at Tampico, Mexico. E. H. Connor. Illustrated description of a finely equipped, steel concrete, fireproof wharf at which the largest vessels can land. 2500 w. Eng News—June 8, 1905. No. 70102.

The Mexican Central Wharf at Tampico. Illustrated description of a finely equipped, steel-concrete, fireproof wharf which will accommodate the largest vessels. Taken from a pamphlet published by E. H. Connor. 6000 w. R. R. Gaz—Vol. XXXVIII., No. 25. No. 70367.

MISCELLANY.

Explosives.

Stowmarket Explosives' Factories. Outlines the history of this factory and the processes used in the manufacture of gun-cotton, reporting a recent visit. The nitric acid factory, and the manufacture of nitro-glycerine, cordite, etc., are also described. Ills. 5000 w. Engr, Lond—June 9, 1905. No. 70312 A.

Reclamation.

Description of a California Reclamation District. E. D. Van Loben Sels. Describes the lands, crops, methods of reclaiming a swamp land protected from overflow by levees and drained by a system of ditches. Ills. 5800 w. Cal Jour of Tech—May, 1905. No. 70327 C.

The United States Reclamation Service. F. H. Newell. Information concerning this service and the work now under construction. 2500 w. Eng News—June 15, 1905. No. 70233.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

New Automatic Telephone Exchange at Columbus, Ohio. Illustrated detailed description. 3500 w. Elec Rev, N Y—June 17, 1905. No. 70268.

Printing Telegraph.

Barclay's Printing Telegraph. Illustrated description of the machine, which gives great promise of being practical. 3000 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70164.

Type-Printing Telegraphs. Donald Murray. Reviews the development and outlines the main difficulties that have beset the introduction of the system. Ills. 3200 w. Elec Mag—May 23, 1905. No. 69961 C.

Typo-Telegraph. Frederick J. Swift. Illustrated description of the system originated by Dr. George A. Cardwell. 2200 w. Elec Rev, N. Y—June 24, 1905. No. 70363.

Space Telegraphy.

Absorption of Electromagnetic Waves by Living Vegetable Organisms. George O. Squire. Discusses some of the difficulties met in transmitting electromagnetic waves over land, describing experiments, giving results, and much interesting information. Ills. 9500 w. Jour of Elec—June, 1905. No. 70285 C.

Recent Developments in Wireless Telegraphy. Translated from *Prometheus*. An illustrated review of improvements, showing the present standing of wireless telegraphy. 3500 w. Sci Am Sup—June 17, 1905. No. 70244.

Wireless Telegraphy Measurements. W. Duddell and J. E. Taylor. Read before the Inst. of Elec. Engrs. A report of tests made to measure the R. M. S. value of the current in the receiving air wire and to determine how this current depends on the arrangement of the transmitting and receiving apparatus and the distance between them. 3000 w. Elect'n, Lond—June 2, 1905. Serial, 1st part. No. 70188 A.

Telegraphy.

The Evolution of the Telegraph in Railroad Work. Charles E. Yetman. Discusses especially the mechanism used in telegraph work and the conditions arising from its use as affecting the telegraph operator. Illustrates and describes the transmitting typewriter. Discussion. 13500 w. Pro N Y R R Club—May 19, 1905. No. 70259.

Telephony.

A Study of Short-Distance Telephony. Valentine Ryan. Considers the installations of short-distance telephones and their working. Elec Engr, Lond—May 26, 1905. Serial. 1st part. No. 70106 A.

Telephone Traffic. Herbert Laws Webb. Describes the improvements that have been made in the conduct of telephone traffic, and discusses the relation between traffic efficiency and engineering economy. 4800 w. Inst of Elec Engrs—May 11, 1905. No. 69936 D.

Time Signals.

The Precise Transmission of Time by Telephone (Transmission Précise de l'Heure par le Téléphone). E. Guyou. The oscillations of a standard pendulum are transmitted by sound, using a special microphone transmitter. 1000 w. Comptes Rendus—May 29, 1905. No. 70433 D.

DISTRIBUTION.

Cables.

Are Lead-Covered Cables Doomed? J. H. C. Brooking. A discussion of the best system of cables to use for the classes of mains now in operation. 3400 w. Elec Mag—May 23, 1905. No. 69964 C.

The Choice of an Insulated Cable. Wallace S. Clark. Read before the Nat. Elec. Lgt. Assn. Gives points to assist in making a wire selection. 4000 w. Elec Rev, N Y—June 10, 1905. No. 70138.

Conductors.

Data Relating to Electric Conductors and Cables. H. W. Fisher. Considers the copper conductor and the insulation, and the pressures that should be applied to different sizes of cables. 2800 w. Am Inst of Elec Engrs—June 19, 1905. No. 70331 D.

Electrical Conductors. A. J. Quigley. Points concerning the manufacture, use, and general characteristics of the various electrical conductors. Ills. 5000 w. Wis Engr—June, 1905. No. 70204 D.

Switches.

High Voltage Oil Switches. Alfred Gradenwitz. Illustrates and describes the design of a German oil switch suggested by Dr. Benischke. 900 w. Engr, U S A—June 15, 1905. No. 70282 C.

ELECTRO-CHEMISTRY.

Concentration.

Electrostatic Concentration. Lucien I. Blake. Discusses the electrostatic separation of ores, describing devices used and their operation. Ills. 2000 w. Eng & Min Jour—June 1, 1905. Serial. 1st part. No. 70028.

Electric Furnaces.

The Borchers Furnace. F. A. J. Fitz Gerald. Describes a furnace used by Despretz in 1849, as the progenitor of the Borchers type, giving data of the latter and the working. Ills. 3500 w. Elec-Chem & Met Ind—June, 1905. No. 70089 C.

Electrometallurgy.

Electrometallurgy of Iron and Steel before the Faraday Society. New information from a paper by F. W. Harbord, read before the Faraday Society. 2500 w. Elec-Chem & Met Ind—June, 1905. No. 70090 C.

Galvanoplasty.

The Electroplating of Leaves and Flowers (Métallisation et Galvanoplastie Artistique des Feuilles et des Fleurs). Francis Marre. Describing an albumino-nitrate of silver process for metallising fragile objects, permitting them to be electroplated with various metals. 1500 w. Génie Civil—May 20, 1905. No. 70423 D.

Review.

Electrometallurgy in the year 1904 (Die Elektrometallurgie im Jahre 1904). Dr. Franz Peters. The first instalment discusses the electric smelting of iron and steel. 5000 w. Glückauf—June 10, 1905. No. 70454 D.

Wires.

The Electrolytic Manufacture of Very Fine Wires (Fabrication Electrolytique de Fils Métalliques trés Fins). Henri Abraham. The wire forms a positive electrode and is slowly dissolved in the electrolyte; the increase in its resistance measures its fineness. 1000 w. Comptes Rendus—May 29, 1905. No. 70435 D.

ELECTRO-PHYSICS.

Alternators.

Alternate Current Machinery—Induction Alternators. William Stanley, assisted by G. Faccioli. Discusses some of the elementary phenomena found while studying the performance of alternators excited by alternating currents. 4800 w.

Am Inst of Elec Engrs—June 22, 1905. No. 70338 D.

The Computation of the Short-Circuit Characteristics of Alternating Generators (Die Vorausberechnung der Kurzschlusscharakteristik von Wechselstrom Generatoren). Dr. Theodor Torda. Deriving formulas and tables for the calculation of the constant from the dimensions and winding. 2500 w. Elektrotech Zeitschr—May 18, 1905. No. 70465 B.

Armatures.

Armature Reaction. Edward Eugene Brown. Read before the Newcastle Soc. of the Inst. of Elec. Engrs. A study, giving report of work of a number of investigators. 3500 w. Elec Engr, Lond—May 26, 1905. No. 70107 A.

Armature Windings of Alternators. F. D. Newbury. A description of armature windings, explaining the characteristics of the unit electromotive forces, and also explaining how the single wires are connected together to form the various types of practical windings and the characteristics of the electromotive forces that result from these various connections. 1500 w. Elec Jour—June, 1905. No. 70221.

Cathode-Ray Tube.

Some Applications of the Braun Cathode-Ray Tube. M. Mansergh Varley and W. H. F. Murdoch. Illustrates and describes a few interesting experiments with the tube. 1300 w. Elect'n, Lond—June 16, 1905. No. 70507 A.

Converters.

External Reactance for Synchronous Converters. Clarence P. Fowler. An explanation of the effect of external reactance on the regulation of rotary converter. 1100 w. Elec Wld & Engr—June 17, 1905. No. 70290.

Dynamotor.

A Diagram of the Circuits of the Dynamotor. A. E. Kennelly and S. E. Whiting. Aims to show that the same principles of graphic representation apply to the circuits of the dynamotor, or direct current transformer, as to the alternating-current transformer. 1000 w. Elec Wld & Engr—June 3, 1905. No. 70070.

Eddy Currents.

Eddy Currents in Large Slot-Wound Conductors. A. B. Field. A discussion of the more important causes of eddy currents in heavy conductors carrying alternating currents and surrounded on their sides by iron. 4500 w. Am Inst of Elec Engrs—June 21, 1905. No. 70333 D.

Electric Waves.

An Experimental Study of Electric Waves and Their Applications. Dr. Edward Branly. An illustrated article studying the production, application, interference, etc. 3000 w. Sci Am Sup—June 24, 1905. No. 70352.

Electromagnets.

The Performance of Different Types of Electromagnets. Charles R. Underhill. Shows the relations between the types in common use. 1000 w. Am Elect'n—June, 1905. No. 70007.

Electrons.

The Dynamics of the Electron (Sur la Dynamique de l'Electron). H. Poincaré. A mathematical examination of the theory of Lorentz, in comparison with the investigations of Laplace upon the action of gravity. 2000 w. Comptes Rendus—June 5, 1905. No. 70437 D.

Hysteresis.

Magnetic Hysteresis Produced by an Oscillating Field Superposed upon a Constant Field (De l'Hysteresis Magnétique Produite par un Champ Oscillant Superposé à un Champ Constant). P. Duhem. Deriving mathematical expressions for the relations of the magnetic effect to the rate of oscillation. 1500 w. Comptes Rendus—May 8, 1905. No. 70429 D.

Power Factor.

Notes on the Power Factor of the Alternating-Current Arc. George D. Shepardson. Presents some results obtained by students at the University of Minnesota, in connection with the graduating thesis work. 1000 w. Am Inst of Elec Engrs—June 22, 1905. No. 70340 D.

Rectifier.

Constant Current Mercury Arc Rectifier. Charles Proteus Steinmetz. An explanation and description of the rectifier system, its operation, characteristics, tests, &c. 4000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70329 D.

Resistance.

The Resistance of Metallic Wires to High-Frequency Currents (Sur la Resistance des Fils Métalliques pour les Courants Electriques de Haute Fréquence). MM. Andre Broca and Turchini. Discussing the application of Kelvin's law to very high frequencies. 1500 w. Comptes Rendus—May 8, 1905. No. 70431 D.

Rheostats.

Water Rheostats. H. M. Phillips. Suggestions for making rheostats, and for increasing or decreasing the resistance, and related matters. 3500 w. Engr. U S A—June 1, 1905. No. 69977 C.

Transformers.

The Design of Transformers. Gives an output formula representing a rule covering various designs from 5 kw. to 1,000 kw. as a basis for calculations. 700 w. Elec Rev, Lond—June 16, 1905. No. 70504 A.

GENERATING STATIONS.

Berlin.

The Moabit Central Station at Berlin, Germany. Emile Guarini. A brief illustrated description of a very large station. 1800 w. Cent Sta—June, 1905. No. 69972.

Central Stations.

Central Station Protection. A symposium of ideas on the protection of Central Stations from interrupted service. 5000 w. Elec Rev, N. Y.—June 3, 1905. No. 70068.

Combined Plants.

Combined Plants for Small Towns. Oscar Claussen. Shows how water and electric lighting plants can be worked together to advantage in small towns. 1000 w. Munic Jour & Engr—June, 1905. No. 69975 C.

Control.

Booster Field Control. Carl P. Nachod. Describes a convenient method of controlling a separately excited booster field. 700 w. Elec Wld & Engr—June 24, 1905. No. 70387.

Denver.

The Electrical Properties of the Denver Gas and Electric Company. C. W. Humphrey. Illustrated review of the electrical developments, and methods used. 4200 w. Elec Rev, N. Y.—June 3, 1905. No. 70066.

Dynamo.

A Novel Type of Dynamos. Illustrated description of a novel type of direct-current dynamo, which is especially suitable for the lighting of railway trains, designed by Dr. E. Rosenberg. 2000 w. Elec Rev, Lond—June 9, 1905. No. 70306 A.

The Erection of a Direct Current Dynamo. L. H. Pike. Directions for the inexperienced, with illustrations. 3000 w. Power—June, 1905. No. 70063 C.

Generating Sets.

Synchronous Converters and Motor-Generators. W. L. Waters. A discussion of synchronous motor generator sets and synchronous converters. Ills. 5000 w. Am Inst of Elec Engrs—June 22, 1905. No. 70335 D.

Turbo Dynamos and Their Associated Machinery (Turbodynamos und Verwandte Maschinen). F. Niethammer. Illustrating and describing a variety of turbo-dynamo sets, for both steam and hydraulic turbines, with details from German and American practice. Two articles. 7000 w. Zeitschr d Ver Deutscher Ing—May 13, 20, 1905. No. 70400 each D.

Hydro-Electric.

A Brief Account of Two Recent Swiss Water Plants. William E. Mott. Illustrates and describes the plants at Engelberg and at Wangen a Aare. The former is representative of the best Swiss practice in water power plants under high heads; the latter an example of design and construction suitable for installations of this character intended for low heads. 2800 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70541 F.

The Hydro-Electric Installation of Turbigo, Lombardy. Enrico Bignami. Illustrated description of a new plant to operate in parallel with the plant at Vizzola. 1500 w. Elec Rev, Lond—May 19, 1905. No. 69942 A.

The Hydro-Mechanical Arrangement of Recent Electric Stations in Austria (Hydromechanische Einrichtungen von Neueren Oesterreichischen Elektrizitätswerken). Gustav Witz. Describing especially the construction of the hydro-electric plant at Bruck, on the Mur, developing about 4000 horse power. 3000 w. 3 plates. Zeitschr d Oesterr Ing u Arch Ver—June 2, 1905. No. 70444 D.

The Hydro-Electric Power Station at Ladernier. S. Herzog. Illustrated description of a power equipment of interest because of the large extent of the hydraulic distributing system, and the many arrangements for safety in operation. 2200 w. Elec Wld & Engr—June 10, 1905. No. 70154.

The Puyallup River Water Power Development and High Tension Transmission to Seattle and Tacoma, Washington. J. F. Vaughan. An illustrated description of this system recently put in operation. 3500 w. Harvard Engng Jour—June, 1905. No. 70206 D.

Ice Disposal.

The Importance of Ice Disposal on Large Hydraulic Power Developments. Edwin E. Haslam. An illustrated article explaining the difficulties caused by ice, and the methods of protection and disposal. 5000 w. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70540 F.

Mining Plant.

The Electric Power and Lighting Station of the Dahlbusch Mine (Die Elektrische Kraft und Lichtanlage der Zeche Dahlbusch). Messrs. Le Bell & Bollmann. Fully illustrated description of the plant, including steam engines, steam turbines, pumps, ventilators, buildings, etc. 4000 w. 4 plates. Glückauf—June 3, 1905. No. 70453 D.

New England.

Electric Transmission and Distribution in New England. Illustrates and describes stations of the Connecticut Railway & Lighting Company at Waterbury, Connecticut. 3400 w. Am Elect'n—June, 1905. No. 70004.

Niagara Falls.

The Development of the Ontario Power Co. P. N. Nunn. A statement of the considerations which led to a departure from the type of construction hitherto installed at Niagara Falls, briefly describing features which may prove to be advances in the art of power-plant design. Ills. 4800 w. Am Inst of Elec Engrs—June, 1905. No. 70252 D.

The Ontario Power Company's Plant at Niagara Falls. E. A. Ekern. Illustrated detailed description. 4800 w. Wis Engr—June, 1905. No. 70203 D.

Power Plant.

Power Plant of the Oliver Plow Co. at South Bend, Ind. Illustrated detailed description of an interesting hydro-electric plant that has been recently improved. 2500 w. Engr, U S A—June 1, 1905. No. 69976 C.

Power Plant Supervision and Accounting. F. W. Ballard. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Describes the system of the Sherwin-Williams Co., of Cleveland, O. 2500 w. Engr, U S A—June 1, 1905. No. 69979 C.

The Power Plant of the University of California. A. S. Wheeler. Illustrated description of the new plant, designed for a full load of 200 kilowatts. Oil is used for fuel. 2000 w. Cal Jour of Tech—May, 1905. No. 70324 C.

South America.

Electrical Power Development in South America. Illustrated detailed description of the results accomplished by the Sao Paulo Tramway, Light & Power Co., in Brazil 2500 w. Can Elec News—May, 1905. No. 69954.

Switchboards.

Some European High Tension Switchboards. Prof. Dr. F. Niethammer. Illustrates and describes some of these boards. 900 w. Elec Wld & Engr—June 3, 1905. Serial. 1st part. No. 70071.

Transformers.

Static Disturbances in Transformers. S. M. Kintner. An explanation of the way in which static disturbances are induced. 1000 w. Elec Jour—June, 1905. No. 70223.

Transformer Insulation. O. B. Moore. Discusses the relation of ohmic resistance and dielectric strength. 2000 w. Elec Jour—June, 1905. No. 70220.

Tunnels.

Electric Equipment at the Karawanken Tunnel. Illustrated description of the electric plant for furnishing power for tunnel construction in Austria, with explanation of some of the uses to which the power is applied. 2800 w. Engr, Lond—June 2, 1905. No. 70201 A.

Turbine Station.

The New Turbine Station of the Edison Electric Illuminating Company of Boston. Illustrated detailed description. 3800 w. Power—July, 1905. No. 70391 C.

LIGHTING.

Filament.

A New Carbon Filament. John W. Howell. Gives a report of a carbon filament having characteristics differing from any previously known, due to the proper application of excessively high temperatures to the ordinary carbon filament. 1800 w. Am Inst of Elec Engrs—June 22, 1905. No. 70337 D.

Illuminants.

Notes on the Use of Rare Earths in Electric Illuminants. Murray Charles Beebe. Discusses the work in this field, the difficulties, and experiments. 2700 w. Am Gas Lgt Jour—June 12, 1905. Serial. 1st part. No. 70126.

Illumination.

The Lighting of Residences. E. Leavenworth Elliott. Discusses the lighting of the kitchen, dining-room, library, parlor, bedrooms, etc. 3000 w. Cent Sta—June, 1905. No. 69974.

Lamps.

Comments on Remarks Made by Col. R. E. B. Crompton before the International Electrical Congress at St. Louis. John W. Howell. Remarks made in discussion of papers read by Mr. Torchio and Mr. Dow are given. Reports tests made of English lamps, and also of American lamps, and discusses conditions in England. 1200 w. Am Inst of Elec Engrs—June 19, 1905. No. 70332 D.

Some Recently Improved Forms of the Electric Lamp. F. C. Caldwell. Abstract of a paper before the Ohio Soc. of Mech., Elec., and Steam Engrs. Reviews briefly the essential characteristics necessary for a first-class source of light, and considers recent improvements in efficiency. 2000 w. Engr, U S A—June 1, 1905. No. 69980 C.

Mercury Arc.

The Mercury Arc Lamp and Rectifier. E. Weintraub. Reviews the history of the mercury arc, and gives an outline of work done in the Research Laboratory of the General Electric Company, discussing some of the practical properties, and the mercury arc rectifier. Also editorial. Ills. 5500 w. Elec Wld & Engr—June 3, 1905. No. 70073.

A New Ultra-Violet Mercury Lamp. Dr O. Schott. Abridged translation of an article in the *Zeitschrift für Angewandte Chemie*. Describes a modification of the Hewitt mercury vapor lamp, and some of the uses to which it is applied. 1800 w. Sci Am Sup—June 10, 1905. No. 70173.

Nernst Lamps.

Some Results of Late Mineral Research in Llano County, Texas. William E. Hidden. An illustrated article describing the development of the noted gadolinite locality, known as Barringer-Hill. 2500 w. Am Jour of Sci—June, 1905. No. 69986 D.

Tantalum Lamp.

Tests of the Tantalum Lamp. Dr. Louis Bell and Prof. W. L. Puffer. A preliminary report of tests made of the life of these lamps, and photometric determinations. Illus. 1500 w. Elec Wld & Engr—June 3, 1905. No. 70069.

MEASUREMENT.

Alternating Currents.

A New Instrument for the Measurement of Alternating Currents. E. F. Northrup. Illustrated description of instrument and methods of measuring alternating current instruments, and large alternating currents regardless of their wave form or frequency. 4000 w. Am Inst of Elec Engrs. —June, 1905. No. 70247 D.

The Measurement of Small Alternating Currents. Frederick Bedell. Description of a simple device for measuring small alternating currents. Also editorial. 1200 w. Elec Wld & Engr—June 10, 1905. No. 70156.

Efficiency Tests.

Efficiency Tests of a 400-Kw. Westinghouse-Parsons Turbo-Generator. Gives method of conducting the tests and the details concerning the calibration of instruments, methods of measurement, etc. 1400 w. Eng Rec—June 10, 1905. No. 70184.

High Pressures.

Methods of Measurement of High Electrical Pressures. S. M. Kintner. A summary of the various methods of high-pressure measurement at present employed, pointing out their advantages and faults, and describing a new type of Westinghouse static voltmeter. 5700 w. Am Inst of Elec Engrs—June, 1905. No. 70253 D.

Induction Motors.

Measuring the Slip of Induction Motors. F. Lawton Stone. Describes a mechanical method of measuring the slip which seems well adapted to workshop conditions. Ills. 1200 w. Elec Wld & Engr—June 10, 1905. No. 70155.

Meters.

Magnetic Motor-Meter for Continuous Currents (Magnet-Motorzähler für Gleichstrom). A form of meter for moderate currents using a motor with permanent magnetic field. 1500 w. Elektrotech Zeitschr—May 18, 1905. No. 70464 B.

Rotary Motor-Meter for Continuous Currents (Rotierende Motorzähler für Gleichstrom). Illustrated description of the A. E. G. rotary meter, as approved by the Reichsanstalt. 1500 w. Elektrotech Zeitschr—May 18, 1905. No. 70463 B.

Oscillating Motor-Meter for Continuous Currents (Oscillierende Motorzähler für Gleichstrom). An official report by the Reichsanstalt upon a form of meter for two and three-wire circuits, for pressures of 60 to 600 volts. Full details are illustrated. 2500 w. Elektrotech Zeitschr—May 18, 1905. No. 70462 B.

Photometry.

Note on the Use of White Walls in a Photometric Laboratory. Edward P. Hyde. Aims to show that photometric observations can be made in any room by arrangements described, and corrections measured. Also editorial note. 2500 w. Elec Wld & Engr—June 3, 1905. No. 70074.

Resistance.

Application of the Differential Galvanometer to Exact Measurements of Resistance. W. Jaeger. Translated from *Zeitschrift fuer Instrumentenkunde.* An explanation of the Kohlrausch method. 2500 w. Elec Rev, N Y—June 17, 1905, No. 70269.

Wattmeters.

Determination of Wattmeter Correcting Factors by Means of the Oscillograph. Stanley P. Smith. An account of experiments made with the main object of finding, by the use of the oscillograph, the magnitude of the correcting factor. 1200 w. Elect'n, Lond—June 16, 1905. No. 70508 A.

MOTORS.

Alternating Current.

Alternating-Current Motors in Industrial Service. P. D. Ionides. Abstract of a paper read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs. Notes on the types used to meet stated requirements. 1500 w. Elect'n, Lond—May 26, 1905. No. 70110 A.

Choice of Motors.

Choice of Motors in Steam and Electric Practice. William McClellan. Discusses this subject, giving a survey of characteristic features of the motive power in the two systems, and calls attention to important points. 4 tables. 2500 w. Am Inst of Elec Engrs—June, 1905. No. 70246 D.

Control.

American Types of Control Apparatus for Direct Current Motors. Laurence B. Mather. Illustrations, with brief descriptions of the various types and their operation. 8700 w. Am Elect'n—June, 1905. No. 70008.

Motor-Controlling Apparatus. Francis W. Appleton. Brief description of a simple arrangement, which is a condensation of solenoid switches, with suggestions. 800 w. Am Elect'n—June, 1905. No. 70005.

Electric Driving.

Some Problems in Electric Motor Driving. H. S. Knowlton. Suggestions for determining the proper motor outfit for any work, with remarks on the advantages to be gained. 1700 w. Cassier's Mag—June, 1905. No. 69966 B.

Induction Motors.

Note on a Simple Device for Finding the Slip of an Induction Motor. Charles A. Perkins. Describes a simple and inexpensive device used in the laboratory of the University of Tennessee. 600 w. Am Inst of Elec Engrs—June 22, 1905. No. 70339 D.

The Design of Induction Motors. Comfort A. Adams. Gives method of calculating the magnetic leakage, a new method for the calculation of the power factor and other matters of interest. 5400 w. Am Inst of Elec Engrs—June, 1905. No. 70245 D.

Worm Gearing.

Worm Gearing for Railway Motors. Henri Somach. Notes applications made of worm gearing, and gives an illustrated description of a new arrangement for vehicle use, and a statement of the advantages. 900 w. St Ry Jour—June 3. 1905. No. 70049 C.

TRANSMISSION.

High-Power Surges.

High-Power Surges in Electric Distribution Systems of Great Magnitude. Charles Proteus Steinmetz. Review and discussion of a high-power surge, which occurred in the high-potential distribution system of the Manhattan Railway, in New York, during the early days of its electric operation. 5000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70328 D.

High Voltage.

High Voltage Direct Current Transmission. G. W. Worrall. Describes the system developed by M. Thury, which generates continuous current at very high tension and constant current, transmits it to the nearest point of demand, continues it in series through all points supplied and returns it through an insulated line. 2000 w. Power—June, 1905. No. 70062 C.

Insulators.

High-Tension Insulators. Illustrated description of the manufacture and electric testing. 3000 w. Elec Rev, N Y—June 3, 1905. No. 70067.

Lightning Arresters.

The Lightning Arrester. Newton Harrison. Shows that if lightning has a choice of paths it will choose the one having the least impedance, explains the purpose of the arrester, and gives a study of the problem of protection. Ills. 2800 w. Cent Sta—June, 1905. No. 69971.

The Siemens-Schuckert Lightning Arrester Relay (Das Blitzableiter-Relais der Siemens-Schuckertwerke). Alberto Dina. Showing the application of auxiliary discharge points to the horn lightning arrester to enable the gap to be safely increased. 4500 w. Elektrotech Zeitschr—May 25, 1905. No. 70468 B.

Masts.

Earth Connections for Masts and Poles for High-Tension Transmissions (Ueber Erdverbindung für Mastenbeschläge und Holzerne Leitungsmasten bei Elektrischen Hochspannungsleitungen). Norberg Schulz. Data from experience in Norway showing the losses of current through the masts and connections. 1500 w. Elektrotech Zeitschr—May 25, 1905. No. 70469 B.

Potential.

An Experimental Study of the Rise of Potential on Commercial Transmission Lines Due to Static Disturbances Caused by Switching, Grounding, etc. Percy H. Thomas. Describes tests made in an experimental study of "static effects" on full-sized commercial systems. 4000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70330 D.

Regulation.

How to Calculate Regulation. J. S. Peck. Simple methods of calculating the regulation of alternating-current circuits are given. 700 w. Elec Jour—June, 1905. No. 70222.

Voltage.

Selection of Transmission Voltages. Alton D. Adams. Suggestions of value, discussing the factors that determine the voltage. 1200 w. Sci Am—June 17, 1905. No. 70241.

MISCELLANY.

Electrical Energy.

The Supply of Cheap Electrical Energy for Industrial Purposes. J. A. Jeckell. Read before the Birmingham Elec Club. Considers the supply from central stations, the advantages of a cheap supply, and the possibility of cheap rates. 5500 w. Elec Engr, Lond—May 19, 1905. No. 69941 A.

Fire Hazard.

The Electrical Fire Hazard. William T. Benallack. Briefly reviews the development of artificial lighting, the various applications of electricity, etc., and discusses fires caused from an electrical source. Discussion. Ills. 13000 w. Jour W Soc of Engrs—June, 1905. No. 70528 D.

History.

Personal Recollections of the Rise of the Electrical Industry. Prof. Elihu Thomson. An extremely interesting record of the early work in lighting and power, and of the steps by which the present enormous growth was reached. It forms a brief autobiographical account of Professor Thomson's own part in the electrical industry. 4500 w. The Engineering Magazine, July, 1905. No. 70487 B.

Machine Design.

Limitations in Direct-Current Machine Design. Sebastian Senstius. Presents a system of design based directly upon general experimental data and the commercial guarantees of the machine. Deals also with the limitations imposed by the quality of brushes obtainable. 4000 w. Am Inst of Elec Engrs—June, 1905. No. 70249 D.

Pressure.

The Protection of Electrical Installations Against Excess Pressure Rises. Remarks on the disturbing influences and their causes, and the resistances used. 1200 w. Elec Engr, Lond—June 9, 1905. No. 70305 A.

INDUSTRIAL ECONOMY

American Commerce.

The Development of American Commerce (Le Développement du Commerce des Etats-Unis). A. Dumas. A study of the exports, imports and manufactures of the past 30 years and the influence of the Panama Canal and the Pan-American railroad upon American commerce. 2500 w. Génie Civil—May 27, 1905. No. 70425 D.

Arbitration.

Compulsory Arbitration. F. Danvers Power. Discusses the results of the Arbitration Act in Australia, arguing against compulsory arbitration. 2000 w. Eng & Min Jour—June 15, 1905. No. 70274.

Cost-Keeping.

Cost Keeping for the Foundry. R. W. M'Dowell. Read before the Am. Found. Assn. Outlines a system of a general nature, showing the main features of foundry cost accounting. 1700 w. Ir Age—June 8, 1905. No. 70086.

Education.

Some Observations on Mechanical Training. D. Hamilton. Read before the Glasgow Tech. College Sci. Soc. Discusses methods of training, with special reference to Gt. Britain. 5500 w. Prac Engr—June 16, 1905. No. 70500 A.

The New Mechanical Buildings of the Dresden Technical High School (Die Neubauten der Mechanischen Abteilung der Kgl. Sächsischen Technischen Hochschule zu Dresden). A very complete and fully illustrated description of the buildings and equipment. 15000 w. 1 plate. Zeitschr d Ver Deutscher Ing—May 27, 1905. No. 70406 D.

Export Trade.

Engineering Exports of Britain, Germany, and the United States. W. Pollard Digby. Tracing, with the aid of graphic charts, the relative volume of business done by the three great nations in the chief trade zones. Ills. 2500 w. The Engineering Magazine—July, 1905. Serial. 2nd part. No. 70482 B.

Engineering Betterments.

The Engineer as an Economist. C. J. H. Woodbury. From an address at Potsdam, N. Y. Calls attention to inventions whose results have raised mankind and improved the conditions of life; and also the economical results obtained. 4000 w. Ir Trd Rev—June 22, 1905. No. 70356.

Engineering Societies.

The Organization and Administration of National Engineering Societies. John W. Lieb, Jr. Presidential address reviewing the four national engineering societies of America, making reference also to corresponding bodies in Europe. 5000 w. Am Inst of Elec Engrs—June 19, 1905. No. 70334 D.

"Engineer's Fault."

The Engineer's Fault: A Discussion of Specifications, Contracts and Law Suits. John Cassan Wait. Condensed from a paper before the Soc. of Munic. Engrs. of N. Y. City. 6500 w. Eng News—June 8, 1905. No. 70099.

Labor.

Insurance Against Loss of Work (Die Fürsorge für Arbeitslose). Paul Möller. An account of some of the schemes for insuring workmen against hardship from lack of work, as in force in certain establishments in Germany. 3000 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70415 D.

Organization.

The Organization of Working Forces in

Large Power-Houses. W. P. Hancock. Read before the Nat. Elec. Lgt. Assn. Describes the organization of the Boston Edison Illuminating Co., at the Third, Fourth and Turbine stations. 6500 w. Eng Rec—June 10, 1905. No. 70183.

Premium System.

The Premium System in Great Britain. J. William Chubb. Explains the attitude of the workmen, methods, results and experiences of various works. 6500 w. Am Mach—Vol. 28, No. 25. No. 70342.

MARINE AND NAVAL ENGINEERING

Battleship.

An Ideal Battleship for the British Fleet. Vittorio Cuniberti. Reprinted from "All the World's Fighting Ships." 2800 w. Marine Rev—June 15, 1905. No. 70258.

Launching of the United States Battleship Nebraska. An illustrated article giving information of the launch and particulars relating to the vessel. 2000 w. Marine Engng—June, 1905. No. 70011 C.

Bending Moments.

Bending Moments of Ships. F. H. Alexander. Read before the Inst. of Naval Archts. A study of the influence of the proportions and form of ships upon their longitudinal bending moments among the waves. Diagrams. 3800 w. Engng—June 9, 1905. No. 70316 A.

Car-Ferry.

Car Ferry Steamer Detroit, Michigan Central Railroad. Illustrated description of a vessel used in the Detroit River service, between Detroit, Mich., and Windsor, Canada. 1100 w. Sci Am Sup—June 3, 1905. No. 69994.

Coaling.

A New Apparatus for Coaling Steamers. An illustrated description of the invention of L. A. de Mayo, and its working. 800 w. Sci Am—June 10, 1905. No. 70169.

Coupling.

The Lovekin Improved Outboard Loose Coupling. Robert S. Riley. Illustrates and describes a type of outboard loose coupling designed with a view to overcoming some of the objections inherent in the sleeve type. 2500 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70521 H.

Cranes.

Shipbuilding Cranes (Hellingkrane). Illustrating electrically driven traveling tower cranes in the Vulcan shipyards at Vegesack, near Bremen. 1000 w. Schiffbau—May 24, 1905. No. 70460 D.

Cruisers.

New Scout Cruisers Chester, Birmingham, and Salem. W. F. Sicard. A detailed description of this class of vessels and the equipment, with comparison with the new British scouts. 4000 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70517 H.

Destroyer.

A Destroyer in Service. Lieut. G. C. Davison. A report of service data for the "Paul Jones." 1800 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70518 H.

The Cavité Floating Dock. Day Allen Willey. Illustrated description of this drydock recently completed for the United States Government in the Philippines. It is entirely of American design and construction, has the greatest lifting capacity of any mechanism ever designed, and many features of interest. 2000 w. Sci Am Sup—July 1, 1905. No. 70551.

Dry Dock.

Cavité Steel Floating Dry Dock. N. A. Berner. Brief illustrated description of a dock costing $1,225,000, for the Philippine waters. 2000 w. R R Gaz—Vol XXXVIII. No. 25. No. 70368.

Floating Dry Docks in Many Navies. Remarks on the value of this type of ship-repairing basin, giving facts in regard to modern dry-docks, and describing the new steel dry-dock for Manila. Ills. 4000 w. Naut Gaz—June 8, 1905. No. 70142.

The Floating Dock of the Aktien Gesellschaft "Neptun," Shipyard and Engine Works, of Rostock, in Mecklenburg. Karl Zublin. Illustrates and describes a dock constructed on the new "Dieckhoff" system. 2700 w. Marine Engng—June, 1905. No. 70013 C.

Fire Boat.

Fire-Extinguishing and Disinfecting Steamer "Clayton." Illustrated description of a steel twin-screw steamer and its equipment. 1000 w. Engng—June 2, 1905. No. 70195 A.

Gas Engines.

The Future of Marine Gas Engines. Peter Evermann. Reviews the development of the gas engine and producer, and states the advantages. Ills. 4000 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70520 H.

German Navy.

The Development of the German Navy (Die Enwickelung der Deutscher Kriegsmarine). H. Haekel. A review of the influence of the development of the German navy upon the progress of German shipbuilding. Serial. Part I. 2000 w. Schiffbau—June 14, 1905. No. 70461 D.

Lifeboat.

The Englehardt Unsinkable Lifeboat. Randolph I. Geare. Brief illustrated description of a boat invented in Copenhagen. 600 w. Sci Am—July 1, 1905. No. 70548.

Marine Shafting.

Recording Angular Velocities of Marine Shafting. John H. Heck. Read before the Inst. of Naval Archts. Notes on the variation of angular velocity in the shafting of marine engines, giving results of many experiments. Ills. 2300 w. Engng—May 26, 1905. No. 70122 A.

Motor Boats.

The Cruise of Napier Major. Extracts from A. F. Evans' report of his recent voyage in this petrol cruising boat. 2000 w. Autocar—May 20, 1905. No. 69934 A.

Oil Engines.

Marine Oil-Engines Consuming Creosote or Other Heavy Oils. Illustrates and describes two medium speed, marine oil-engines recently built by the Griffin Engng. Co., with notes of trials. 2500 w. Engng—May 19, 1905. No. 69946 A.

Reckoner.

Electric Dead Reckoner Used on "Valhalla" in the Ocean Race. Illustrates and describes an automatic dead reckoner and recorder. 1200 w. Sci Am—June 3, 1905. No. 69992.

Scouts.

H. M. Scout "Forward." An illustrated description of this vessel and its equipment, with a report of her most satisfactory performance. 1800 w. Engng—May 19, 1905. No. 69943 A.

Shipping.

The Shipping and Shipbuilding of Puget Sound. Frank W. Hibbs. Read beforce the Soc. of Naval Archts. and Marine Engrs., New York. Information concerning the great number of vessels their types, the most important items of commerce, etc. Ills. 3000 w. Naut Gaz—June 22, 1905. Serial. 1st part. No. 70373.

Ships.

The Geometry of the Form of Ships (Beitrag zur Geometrie der Schiffsform). O. Richter. A mathematical analysis of the lines of a ship's hull, with numerous tables and diagrams to aid in the practical application of the theory. Four articles. 8000 w. Schiffbau—April 26, May 10, 24, June 14, 1905. No. 70457 each D.

Steamboats.

London County Council Steamboat Service. Brief description of the vessels for the new Thames steamboat service and their engines. 1500 w. Engng—June 16, 1905. No. 70513 A.

Long Island Sound Steamboats. Illustrated detailed description of the recently completed steamboat "Providence," with illustrations of many of the Sound boats, and a tabulated list of these boats. 4000 w. Naut Gaz—June 1, 1905. No. 70043.

The Steamboats of Monmouth County. C. B. Parsons. A review of the history of the Shrewsbury River boats, and others in service from Monmouth County, N. J., to New York. 2500 w. Naut Gaz—June 22, 1905. Serial. 1st part. No. 70374.

Steamships.

Description of Steamship Dakota and Her Official Trial Performance. A. Gundersen. Illustrations, and description of this vessel built for trans-Pacific service. 10500 w. Jour Am Soc of Nav Engrs—May 1, 1905. No. 70522 H.

The Great Northern Steamship Dakota. Illustrated detailed description of this large ship, constructed for the American merchant marine for over-sea trade. 800 w. Marine Engng—June, 1905. No. 70015 C.

The New Steamship Bermudian. Illustrated detailed description of a fine steamship in service between New York and Bermuda. 1000 w. Marine Engng—June, 1905. No. 70010 C.

The Turbine Steamship "Victorian." Report by Com. A. B. Canaga, describing the equipment, and operation. Ills. 5000 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70523 H.

Submarines.

Submarines, "A" and "B" Class. Illustrates British submarines of these two classes, giving brief notes. 350 w. Engr. Lond—June 16, 1905. No. 70515 A.

Submarines. Sir William H. White. From the Engineering supplement of the London *Times*. The present article reviews the history of the construction of these vessels in England and France. 4000 w. Sci Am Sup—June 10, 1905. Serial. 1st part. No. 70172.

Submarine Signalling.

Submarine Signalling by Means of Sound. J. B. Millet. Read before the Inst. of Naval Archts. A review of investigations in this field, and especially recent work and its great value, explaining the system. 4000 w. Engng—May 19, 1905. No. 69948 A.

Torpedoes.

The Protection of Vessels against Torpedoes and Mines (Schutz der Schiffe gegen Torpedos und Minen). Messrs. R. Blochmann and G. Neudeck. A study of torpedo warfare, and the improvements in modern warship construction designed to resist their attack. Three articles. 5000 w. Schiffbau—April 12, 26, May 10, 1905. No. 70455 each D.

Transferring Machine.

A Transferring Machine for Ship's Lines, etc. Herman Jonson. Illustrates and describes a machine, designed by the writer, for work in the shipbuilding trade. 1400 w. Am Mach—Vol. 28, No. 23. No. 70132.

Troopship.

The Troopship Dufferin. Illustrated detailed description of the largest and most powerfully armed troopship yet built. 2000 w. Engr, Lond—May 26, 1905. No. 70124 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Clutches.

A Little Talk on Cone Clutches. Rene M. Petard. Discusses this device, and also other types. 1200 w. Automobile—June 1, 1905. No. 69984.

Dust.

Motor Cars and Dust. On the effect of design on the raising of dust, stating the conditions and discussing how far they may be eliminated. 2300 w. Engr, Lond—June 16, 1905. No. 70514 A.

Electric Buckboard.

How to Make an Electric Buckboard. J. C. Brocksmith. An illustrated article, with directions. 1800 w. Am Elect'n—June, 1905. No. 70009.

Eliminating Trials.

The Isle of Man Eliminating Trials. An illustrated report with tabulated results. 4500 w. Auto Jour—June 3, 1905. No. 70185 A.

Fire Engines.

Automobile Fire Engines. George Glendon. An illustrated article presenting the advantages of these machines. 1000 w. Cassier's Mag—June, 1905. No. 69965 B.

Fuel Economy.

Fuel Economy in Car Driving. E. W. Walford. Suggestions showing the good and bad methods. 2800 w. Autocar—May 27, 1905. No. 70104 A.

Gearing.

Transmission Gearing Efficiency Test. Rene M. Petard. An illustrated report of experiments recently carried out in France to determine the efficiency of the transmission gearing of the modern automobile. 1200 w. Automobile—June 22, 1905. No. 70357.

The Hitchon Change Speed Gears. Illustrated description of this gear which at the instant of changing is so arranged that the next higher or lower speed gear wheels must be in mesh before the other transmission gearing of the modern autocar—June 10, 1905. No. 70300 A.

Hill Climbing.

Climbing Dead Horn Hill in Worcester. An illustrated account. 2200 w. Automobile—June 1, 1905. No. 69983.

Mail Wagons.

Electric Mail Automobiles. Illustrated description of vehicles in use in Paris, and in the United States. 1200 w. Sci Am—June 3, 1905. No. 69991.

Military.

Automobiles for Military Transport (Transports Automobiles Militaires). Lt. Col. G. Espitallier. Describing the successful use of a Brillié petrol truck in hauling a train of artillery in the Portuguese army. 3000 w. 1 plate. Génie Civil—June 10, 1905. No. 70428 D.

Municipal Vehicles.

Municipal Vehicles in the City of Paris. Illustrated descriptions of various types used, with report of their success. 1600 w. Automobile—June 8, 1905. Serial. 1st part. No. 70143.

Omnibus.

Automobile Omnibus in Paris (Les Omnibus Automobile à Paris). Lt. Col. G. Espitallier. A detailed description of the Gardner-Serpollet steam omnibus now in successful operation in Paris. 2000 w. 1 plate. Génie Civil—May 20, 1905. No. 70421 D.

Racing Car.

The 1905 Renault Racing Car. An illustrated article giving particulars of these cars. 1500 w. Autocar—June 10, 1905. No. 70301 A.

Simms-Welbeck.

The 1905 Simms-Welbeck Cars. Begins an illustrated description of these British built cars. 500 w. Auto Jour—June 10, 1905. Serial. 1st part. No. 70302 A.

Steering.

Analysis of Steering-Knuckle Angles of Automobiles. Herbert L. Towle. Discusses the most suitable angles of inclination of the arms of the steering knuckles with respect to the wheel base and other conditions involved. 1300 w. Am Mach—Vol. 28, No. 23. No. 70136.

Touring Cars.

St. Louis Four-Cylinder Touring Car. Illustrates and describes a car built with a view to obtaining great motor flexibility. 1800 w. Automobile—June 8, 1905. No. 70144.

Truck.

Mitchell 1,500-Pound Gasoline Truck. Illustration, with description, and remarks on novel features. 1300 w. Automobile—June 15, 1905. No. 70256.

New Type of Electric Truck. Illustrated description of a truck fitted with a single electric motor within each wheel. 1000 w. Sci Am—June 24, 1905. No. 70350.

COMBUSTION MOTORS.

Alcohol.

Alcohol as a Fuel for Motors. From a paper by Dr. Ormandy before the Western Sec. of the Scottish Auto. Club. The present article discusses the heat required to vaporize, the range of explosibility, and the boiling points. 1200 w. Automobile—June 15, 1905. Serial. 1st part. No. 70255.

Carburetter.

The Napier Carburetter. Illustrates and describes the present type of Napier carburetter. 1000 w. Autocar—June 17, 1905. No. 70398 A.

Diesel.

500-Horse-Power Diesel Engine at the Liege Exhibition. Illustrations, principal dimensions and description. 1100 w. Engng—June 9, 1905. No. 70314 A.

The American Diesel Engine. E. D. Meier. An explanation of the working of this engine, with illustrations, and a comparison with the thermal efficiencies of a steam engine. 3000 w. Harvard Engng Jour—June, 1905. No. 70207 D.

Gas Engines.

Gas Engines and Their Breakdowns. Extract from an article in the *Vulcan*, giving details of gas-engine crank shaft failures, with comments. 1500 w. Mech Engr—June 3, 1905. No. 70186 A.

Large German Gas Engines. Abstract of an address delivered before the Soc. of German Engrs. by Prof. Riedler, who describes and criticises the principal makes of large gas engines built in Germany, and gives a short history of internal combustion engines in general. Ills. 3500 w. Ir Age—June 22, 1905: Serial. 1st part. No. 70345.

The Cockerill Gas-Engines at the Liége Exhibition. Two illustrations and brief descriptions of the three engines exhibited. 600 w. Engng—June 2, 1905. No. 70194 A.

The Mechanical Efficiency and Indicated Capacity of the Gas Engine. (Der Mechanische Wirkungsgrad und die Indizierte Leistung der Gasmachine.) Rudolf Diesel. An exmination of the various conditions under which the efficiency of an internal-combustion motor may be stated, with especial reference to the tests of the Diesel motor. 3000 w. Zeitschr d Ver Deutscher Ing—May 20, 1905. No. 70405 D.

The Present Position of the Gas Engine. Horace Allen. Outlines the combination, fully proved to be satisfactory, which, in the writer's opinion, explains the present position. Also considers points bearing on this subject. 1200 w. Elec Rev, Lond—May 26, 1905. No. 70109 A.

See also Marine Engineering.

Gasoline Motor.

The Lister Two-Cycle Twin-Piston Engine. Illustrations, sectional views, and description of the working. 700 w. Sci Am Sup—June 17, 1905. No. 70243.

Petrol Engine.

The Pollard Compound Petrol Engine. An illustrated article explaining the principle and construction of this engine. 2000 w. Auto Jour—May 20, 1905. No. 69935 A.

See also Marine Engineering, Oil Engine.

Producer-Gas.

Producer-Gas Power Plants. A. Frederick Collins. Illustrates and describes two forms of the suction type of apparatus, the Loomis-Pettibone system, and the Crossley system. 2000 w. Sci Am Sup—June 3, 1905. No. 69997.

Starting.

Methods and Suggestions for the Starting of Gas Engines. R. Mathot. Describes the various systems adopted—mechanical, explosion, etc., and advocates particularly the use of compressed air according to a plan described in detail. 1800 w. The Engineering Magazine—July, 1905. No. 70486 B.

Waste Gases.

Power From Waste Furnace Gases. Brief illustrated descriptions of some of the largest installations of gas engines for utilizing the waste gases from blast furnaces. 1400 w. Power—June, 1905. No. 70064 C.

Wood Gas.

Wood Gas for Power Purposes and Gas Generators. George M. Douglas. Read before the Inst. of Min. and Met. Describes the plant of the Montezuma Copper Co., at Nacozari, Mexico, and its operation. Ills. 3500 w. Inst of Min and Met—April 13, 1905. No. 70114 D.

HEATING AND COOLING.

Heating Plant.

Heating and Ventilating System of the Majestic Theatre, Boston, Mass. Plans and description of the interesting features of this plant. 1300 w. Eng Rec—June 17, 1905. No. 70297.

Low Temperatures.

The Production of Very Low Temperatures. Begins a review of work in this field referring to the British exhibit at the St. Louis Exhibition and the lectures given there. Ills. 2500 w. Engr, Lond—June 2, 1905. Serial. 1st part. No. 70197 A.

HYDRAULICS.

Centrifugal Pumps.

The Efficiency of Centrifugal Pumps (Die Kreisel und Ihre Leistungen). H. Hagens. Giving details of construction of several centrifugal and turbine pumps, with tabulated tests of their performance. 4000 w. Zeitschr d Ver Deutscher Ing—May 20, 1905. No. 70404 D.

Governor.

The Bouvier Governor for Water Turbines. Dr. Alfred Gradenwitz. Illustrated description of an apparatus in which any disturbance occurring in the resisting work is corrected by a corresponding displacement of the gate mechanism. 1400 w. Mach, N Y—June, 1905. No. 70001 C.

Pumps.

Types of Centrifugal Pumps. William O. Webber. Considers recent improvements in these pumps, methods of balancing compound pumps, etc. Illustrates types. 1500 w. Cassier's Mag—June, 1905. No. 69970 B.

Water Power.

Water Power Development at Little Falls, Minn., and Its Industrial Results. Arthur Warren. Describes the conditions at this city on the upper Mississippi River, the water storage system, natural power advantages, dam, power station, industries, etc. Ills. 3500 w. Eng Rec—June 3, 1905. No. 70052.

Water-Powers.

Water-Powers of the Southeastern Appalachian Region. Frederick A. C. Perrine. Considers the powers in the states of Virginia, North Carolina, South Carolina, Georgia, and Alabama. 4500 w. Am Inst of Elec Engrs—June 22, 1905. No. 70336 D.

See also Electrical Engineering, Generating Stations, Hydro-Electric.

MACHINE WORKS AND FOUNDRIES.

Armor Plate Machinery.

Armor Plate Nut-Facing and Chamfering Machine. Illustrates and describes two machines, made in England, for facing, chamfering and turning cylindrical parts of armor plate nuts. 600 w. Am Mach—Vol. 28. No. 26. No. 70535.

Castings.

Casting a Slide-Valve Cylinder. R. H. Palmer. Illustrated description of method used. 1200 w. Am Mach—Vol. 28, No. 25. No. 70343.

Corners on Castings. Walter J. May. An illustrated article showing that rounded edges are stronger than angles, and discussing points bearing on the strength of castings. 1200 w. Prac Engr—June 9, 1905. No. 70304 A.

Melting Steel with Cast Iron. R. P. Cunningham. Read before the Am. Found. Assn. Points on the selection of pig iron and scrap, and the care in charging the cupola to secure strong castings that will machine easily. 1800 w. Ir Age—June 8, 1905. No. 70084.

Copper Plating.

Notes on Copper Plating of Steel Parts of Sights at the Naval Gun Factory. Titus Ulke. Gives briefly the data on which good practice in copper plating is based. 600 w. Am Mach—Vol. 28. No. 23. No. 70135.

Cores.

Venting of Cores. Jas. A. Murphy. Read before the Am. Found. Assn. Describes a machine for making the wax wire used for venting, with speed and economy. Ills. 900 w. Ir Trd Rev—June 8, 1905. No. 70140.

Cupolas.

The Cupola System of the Michigan Store Company. W. J. Keep. Read before the Am. Found. Assn. Describes this plant and the performance of the cupolas and blower. 1400 w. Ir Age—June 8, 1905. No. 70085.

Dies.

A Novel Blanking and Piercing Die. C. F. Emerson. Illustrated explanation of a useful die. 900 w. Am Mach—Vol 28. No. 24. No. 70229.

Drill.

An English Two-Spindle Radial Drill and Some Workshop Gages. I. William Chubb. Illustrated descriptions. 600 w. Am Mach—Vol. 28. No. 26. No. 70533.

Electric Driving.

Installing Electric Machinery. Norman G. Meade. Suggestions for light and power wiring in shops and foundries. Ills. 500 w. Power—July, 1905. No. 70303 C.

Flasks.

Flasks for Brass Foundries. C. Vickers. Read before the Am. Found. Assn. Gives an excellent shape for a flask for all kinds of brass work, discussing also the advantages of an overhead track in the foundry. 900 w. Ir Age—June 8, 1905. No. 70087.

Foundry.

Foundry Department of the Imperial Works of the Oil Well Supply Company, Oil City, Pa. Illustrated description of the gray iron and malleable foundries. 1800 w. Foundry—June, 1905. No. 70226.

Foundries of the Pennsylvania R. R. at Altoona. Illustrated detailed description of one of the largest and best equipped foundry plants in the United States. 4000 w. Ry & Engng Rev—June 10, 1905. No. 70177.

Iron and Steel in the Foundry. E. L. Rhead. Discusses the suitability of a metal for making castings, the extrusion of impurities during solidification, influence of specific and latent heat, etc. Ills. 2400 w. Mech Engr—May 27, 1905. Serial. 1st part. No. 70112 A.

Some Difficulties Met With in Small Jobbing Foundries. Walter J. May. Suggestions for overcoming such difficulties. 1700 w. Prac Engr—June 16, 1905. No. 70309 A.

Some Mechanical Relics of the Civil War. Illustrated description of a confederate gun factory and its equipment, in Virginia. 2000 w. Am Mach—Vol. 28, No. 23. No. 70130.

Gear Cutting.

New Brown & Sharpe Automatic Gear Cutting Machine. Illustrated detailed description. 1500 w. Ir Age—June 29, 1905. No. 70524.

Practical Hints on Gear Cutters. T. S. Bentley. Discusses points in the replacing of broken or worn gears from the standpoint of practice. Gives table for the selection of cutters for bevel gears. 1200 w. Am Mach—Vol. 28. No. 25. No. 70341.

The Nardin Bevel Gear Cutter. Georges Levy, in the *Revue Industrielle*. Illustrated description of a bevel gear generating machine and its operation. 1700 w. Am Mach—Vol. 28. No. 23. No. 70131.

Grinder.

A New Electrically-Driven Toolroom Grinder. Illustrated description of a machine arranged for direct connected motor driving. 1100 w. Am Mach—Vol. 28. No. 22. No. 70018.

Index Plate.

Making an Accurate Index Plate. Otto Eckelt. An illustrated description of method. 500 w. Am Mach—Vol. 28. No. 24. No. 70230.

Lathes.

Analysis of Some Engine-Lathe Drives. Sketches and table giving results of work undertaken to determine which of nine lathes of various sizes and makes were best suited to certain diameters of work; also which were most suitable for the heaviest work. 2000 w. Am Mach—Vol. 28. No. 23. No. 70134.

3x36 Turret Lathe. Illustrated description of a tool exhibited at the St. Louis Exposition. 1300 w. Am Mach—Vol. 28. No. 24. No. 70231.

Melting Ratios.

Some Retort Coke Melting Ratios. C. M. Schwerin. A report of some tests made by the writer. 2200 w. Ir Age—June 15, 1905. No. 70210.

Metal Mixers.

Metal Mixers for Pipe Foundries. J. B. Nau. Read before the Am. Found. Assn. Remarks on European practice in pipe foundries, and the advantages of the heated mixer. 1700 w. Ir Age—June 8, 1905. No. 70088.

Milling Machine.

Vertical Milling Machine. Illustrated description of a machine made in Birmingham, England. 1200 w. Engr, Lond—June 2, 1905. No. 70200 A.

New Works.

The Close Works, Gateshead. Illustrated description. 2700 w. Engr, Lond—May 19, 1905. No. 69950 A.

The Brighton Works of the Reason Manufacturing Co., Ltd. Illustrated description of the works and some of the meters, fans, arc lamps, and other accessories manufactured. 3300 w. Elec Mag—May 23, 1905. No. 69963 C.

The New Pawling and Harnischfeger Plant. Illustrated description of a Milwaukee plant for the manufacture of cranes, hoists, boring mills, steam sawmill feeding engines and electrical machinery. 3000 w. Ir Age—June 15, 1905. No. 70209.

The New Works of the Ingersoll-Sergeant Drill Company at Phillipsburg, New Jersey. Full illustrated detailed description of these fine works and their equipment. 3500 w. Am Mach—Vol. 28. No. 22. Serial. 1st part. No. 70017.

Patterns.

Aluminum as a Pattern Metal. H. N. Tuttle. Discusses the advantages of this metal and also the objections. 3500 w. Foundry—June, 1905. No. 70228.

Care and Storage of Patterns. H. M. Lane. Read before the Am. Found. Assn. Considers methods of storing metal and wood patterns, the protection against fire, etc. 1500 w. Ir Age—June 22, 1905. No. 70344.

Skeleton Patterns. H. J. M'Caslin. Illustrated description of the construction of the skeleton and method of making the mold. 1600 w. Foundry—June, 1905. No. 70227.

Pipe Joints.

Some New Forms of Flanged Pipe Connections for High-Pressure Superheated Steam and Hydraulic Work. Luther D. Lovekin. Gives illustrations, with brief descriptions, of joints which the writer considers most suitable for the uses named. 1300 w. Am Mach—Vol. 28. No. 23. No. 70133.

Test of Pipe Joints. From a report by Com. T. F. Burgdorff. Describes tests in expanding, flaring and facing a 20-in. lap-welded steel pipe, 3/8-in. thick, into a grooved steel flange by a Lovekin pipe-flanging machine, and the testing of various forms of flanges by hydraulic pressure. Ills. 5500 w. Jour Am Soc of Nav Engrs—May, 1905. No. 70519 H.

Planing Machine.

Heavy Vertical and Horizontal Planing Machine. Illustration and brief description of a machine made in Scotland. 600 w. Engng—June 2, 1905. No. 70196 A.

High-Speed Planers. A. L. De Leeuw. Discusses planing machine driving and the adapting of planers to the use of high-speed steel. 10000 w. Mach, N Y—June, 1905. 70000 C.

Planing Machine Drives. C. H. Benjamin. Discusses this subject with special reference to American practice in motor connection, and gives an illustrated description of a method exhibited at the St. Louis Exposition. 2200 w. Cassier's Mag—June, 1905. No. 69969 B.

Plaster of Paris.

Plaster of Paris in the Foundry. Edward B. Gilmour. Read before the Am. Found. Assn. Describes the method of using this material with success. Ills. 700 w. Ir Trd Rev—June 8, 1905. No. 70141.

Power Plant.

The Power Plant of the Ingersoll-Sergeant Drill Company's Works at Phillipsburg, N. J. Illustrated detailed description of a plant where the power is generated in a central power station and distributed by electricity and compressed air to the various points at which it is required. 2200 w. Power—June, 1905. No. 70060 C.

Purchase Department.

The Relation of Purchasing to Economical Production. Wm. D. Ennis. Detailing a plan for organizing the duties and systematizing the work and records of the purchasing agent to the highest advantage of the efficiency of the factory. Ills. 4000 w. The Engineering Magazine—July, 1905. No. 70483 B.

Rivets.

Hydraulic-Driven Rivets. Frank B. Kleinhans. Directions for good work in rivet driving. Ills. 900 w. Boiler Maker—June, 1905. No. 70153.

Stacks.

Development of Bottom Cone for Stack. T. J. M'Dermott. Drawings and description of a successful scheme. 250 w. Boiler Maker—June, 1905. No. 70152.

Turning Mill.

Mill for Turning and Finishing Boiler Heads (Drehwerk zum Abdrehen und Ausschneiden von Kesselboden). With photograph and details of a vertical turning lathe, especially adapted for finishing pressed-steel boiler heads. 1000 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70417 D.

Type-Casting.

The Stringer Type Composing and Casting Machine. Illustrated description of an ingenious machine for composing and casting type. 2500 w. Engr, Lond—June 16, 1905. No. 70516 A.

Welding.

A New System of Welding. Prof. A. H. Sexton. Describes a system of welding by means of the oxy-hydrogen flame. 1600 w. Mech Engr—June 17, 1905. No. 70501 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Copper Alloys. L. Guillet, in *Revue de Métallurgie.* A report of researches in special brasses and quenching of bronze. Ills. 1100 w. Ir and Steel Mag—June, 1905. Serial. 1st part. No. 70224 D.

On the Magnetic Qualities of Some Alloys Not Containing Iron. J. A. Fleming. and R. A. Hadfield. An account of preliminary results obtained in experimental investigations of magnetic alloys. 3000 w. Elect'n Lond—June 16, 1905. No. 70505 A.

On the Natural Iron-Nickel Alloy, Awaruite. George S. Jamieson. Describes two iron-nickel alloys from adjoining locations. 1000 w. Am Jour of Sci—June, 1905. No. 69985 D.

Cast Iron.

The Effect of Manganese in Low Silicon Cast Iron. H. C. Loudenbeck. Read before the Am. Found. Assn. A report of tests made to show the effect of manganese on the chill and fracture of cast iron having a low percentage of silicon. 1000 w. Am Mfr & Ir Wld—June 15, 1905. No. 70257.

The Testing of Cast Iron. Dr. Richard

Moldenke. A summary of modern practice. Also discussion. 6200 w. Jour Fr Inst—June, 1905. No. 70217 D.

Chilled Wheels.

The Manufacture of Chilled Wheels. P. H. Griffin. Presents the wheel maker's position in the controversy over the failure of such wheels under high capacity cars. 3500 w. R R Gaz—Vol. XXXVIII. No. 24. No. 70264.

Rivets.

The Shearing Strength of Rivets. Report read at the Chicago convention of the Master Steam-Boiler Makers. 1200 w. Ir Age—June 29, 1905. No. 70525.

Toughness.

The Modifications in the Toughness of Boiler Plate with Increase in Resistance (Die Aenderung der Zähigkeit von Kesselblechen mit Zunahme der Festigkeit). C. Bach. With tables and diagrams giving the results of numerous tests showing the reduction in elongation with increase in breaking resistance. 2000 w. Zeitschr d ver Deutscher Ing—May 13, 1905. No. 70401 D.

MEASUREMENT.

Calorimetry.

Observations upon Calorimetric Methods (Observations sur les Méthodes Employés en Calorimétry). M. Berthelot. A study of the determination of the heat of combustion of organic substances by means of the calorimeter. 2500 w. Comptes Rendus—June 5, 1905. No. 70436 D.

The Commercial Value of the Lewis Thompson Calorimeter. J. S. S. Brame. Summarizes results given in two recent papers, and gives further information showing that only approximate results can be obtained with bituminous coals, while with other coals the figures have no value. 1800 w. Engr, Lond—May 19, 1905. No. 69949 A.

The Junker Calorimeter for the Determination of Heating Values (Das Junkers-Kalorimeter als Heizwertanzeiger). P. Meyer. A brief discussion of the method of using the Junker calorimeter in such manner as to obtain the thermal values of gaseous fuels with a high degree of precision. 1200 w. Zeitschr d ver Deutcher Ing—June 3, 1905. No. 70411 D.

Flow.

A New Method of Using the Pitot-Darcy Tube to the Measurement of the Velocity of Water in Pipes (Nouveau Mode d'Application du Tube de Pitot-Darcy à la Mesure de la Vitesse des Conduites d'Eau Sous Pression). H. Bellet. By using a liquid of different density than water in one leg of a U-tube, very precise readings may be made. 800 w. Comptes Rendus—June 5, 1905. No. 70439 D.

Fourier's Analysis.

Fourier's Analysis Applied to the Plain Slide Valve Gear. W. F. Durand. A discussion of the application of this method to the motion of the plain slide valve gear, with special reference to its comparison with the motion of the piston expressed by the same form of expansion. 1800 w. Sib Jour of Engng—June, 1905. No. 70205 C.

Integrator.

Amsler's Mechanical Integrators. Cecil H. Peabody. An illustrated explanation of this instrument for determining moments and moments of inertia of plane figures. 4000 w. Marine Engng—June, 1905. No. 70012 C.

Pitot Tube.

The Pitot Tube as an Instrument for Measuring the Velocity of Water Flowing in Closed Tubes. Raymond S. Daniels. Describes investigations performed in the hydraulic laboratory of the University of California, their objects, and the results. Ills. 3000 w. Cal Jour of Tech—May, 1905. No. 70326 C.

Speeds.

Method of Calculating Cone-Pulley and Back-Gear Speeds. E. J. Lees. Gives table, with explanation of method. 900 w. Am Mach—Vol. 28. No. 23. No. 70137.

Testing Instruments.

Types of German Testing Instruments. Dr. Alfred Gradenwitz. A brief illustrated review of types exhibited at the recent Jubilee of the German Electrical Society. 2000 w. Elec Mag—May 23, 1905. No. 69962 C.

Testing Station.

The Materialprüfungsamt Near Berlin. A description of the new testing station in one of the suburbs of Berlin, which was recently completed, and of the equipment for testing various materials. 2500 w. Engng—June 16, 1905. No. 70511 A.

Torsion.

The General Applicability of the Torsion Formula of Saint Venant (Mitteilung zur Gültigkeit der Saint-Venantschen Formal für den Verdrehungswinkel). C. Bach. A brief note, showing the inapplicability of the formula to prisms of all sections. 600 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70416 D.

POWER AND TRANSMISSION.

Ball Bearings.

Experiments upon the Efficiency of Ball Bearings. (Expériences sur le Rendement des Roulements à Billes). Describing the experiments of M. Gégauff at Mulhouse, Alsace, with a special form of dynamometer, upon the resistance of various designs of ball bearings. 1500 w. Génie Civil—May 20, 1905. No. 70422 D.

Belts.

Horse-Power of Belting. N. A. Carle. Diagram for computing the horse-power, with explanation of its use. 700 w. Power—June, 1905. No. 70061 C.

Compressed Air.

Air Compression in Great Britain. James Tonge. Illustrated description of a number of the leading compressor plants at mines. 4000 w. Mines & Min—June, 1905. No. 70083 C.

Tests of a "Reidler" Two-Stage Air Compressor. William D. Hamilton. A report of trials made to demonstrate the capacity and efficiency of a "Reidler" compressor. Ills. 1000 w. Prac Engr—May 26, 1905. Serial. 1st part. No. 70111 A.

Clutch.

The Friction Clutch. John Edgar. Considers only the expansion-ring frictions, explaining the theory of its action, and the design. 900 w. Am Mach—Vol. 28. No. 26. No. 70534.

Flywheels.

Fly Wheel Explosions. William H. Boehm. Remarks on the frequency of these disasters, their causes, the safe speeds for various types of wheels, etc. Ills. 4000 w. Ins Engng—June, 1905. No. 70319 C.

Gas Power.

A Commercial Comparison between Blast Furnace Gas Engines and Steam Engines in the Minette District (Des Wirtschaftliche Verhältnis zwischen Gichtgasmotoren und Dampfmaschinen im Verhüttungsgebiet der Minette). L. Ehrhardt. A detailed examination of the cost of power from gas and steam in iron works in Germany. 4000 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70410 D.

Gearing.

See Mechanical Engineering, Automobiles.

Gears.

An Example of Worm Gearing. Oscar E. Perrigo. Illustrated description of a mechanism that has met successfully very rigid requirements. 1400 w. Mach, N Y—June, 1905. No. 70002 C.

New Devices.

Two New Power Transmission Devices. Brief illustrated descriptions of Pope's spring sprocket, and the Newman variable-speed gear. 1500 w. Eng News—June 8, 1905. No. 70096.

Valves.

Progress in Valves for Air and Gas Compressors. Leicester Allen. Discussing the problems presented to the designer, the difficulties characteristic of various types of compressors, and the improbability of finding any completely satisfactory solution. 2600 w. The Engineering Magazine, July, 1905. No. 70484 B.

Wire Rope.

Wire Rope Transmission. C. Boysen. States their advantages over hemp rope, and gives information of value relating to their use. Ills. 900 w. Power—June, 1905. No. 70065 C.

STEAM ENGINEERING.

Belleville.

The Belleville Exhibit at the St. Louis Exposition. (Die Ausstellung der Société Anonyme des Etablissements Delaunay-Belleville). Fr. Frolich. An illustrated review of the latest types of Belleville engines and boilers as shown at the St. Louis exposition. 1800 w. 1 plate. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70414 D.

Boiler Efficiency.

The Real Efficiency of Steam Boilers. W. H. Booth, Calls attention to errors in the customary method of calculating the efficiency. 1000 w. Elec Rev, Lond—May 26, 1905. No. 70108 A.

Test of Parker Water-Tube Boilers. Describes the installation in a power station of the Philadelphia Rapid Transit Co., reporting test. Ills. 1200 w. Eng Rec—June 24, 1905. No. 70384.

Boiler Plants.

Boiler Plants in Bleaching and Dying Mills. George I. Rockwood. Abstract of a paper read before the N. E. Cotton Mfrs. Assn. Suggestions for the arrangement and the economical working. 2500 w. Engr, U S A—June 1, 1905. No. 69978 C.

Boilers.

Boilers at the Liége Exhibition. Illustrations, with brief descriptions of the Solignac-Grille, the Jacques-Piedboeuf, and the Bailly-Mathot boilers. 1800 w. Engng—June 9, 1905. No. 70315 A.

Steam Boilers at the Liége Exhibition. Describes the boilers exhibited by Messrs. Vve. L. de Naeyer & Co., illustrating one of the water-tube boilers. 500 w. Engng—May 26, 1905. No. 70119 A.

The Computation of the Strength of a Water-Tube Boiler (Festigkeits Berechnung eines Wasserrohrkessels). Detailed calculations for a water-tube boiler of the Thornycroft-Schulz type. 1500 w. Schiffbau—April 12, 1905. No. 70456 D.

Compounding.

Compound Reversing Engines. Willibald Trinks. Presents the advantages of compound condensing reversing engines, discussing the cross compound and twin tandem compound, etc. Also discussion. Ills. 4200 w. Pro Engrs Soc of W Penn—June, 1905. No. 70321 D.

Test of a Compound Engine. Report by Michael Longridge of a test made on a vertical two-crank engine, with general description of the engine, boiler and superheater, in which all previous records were beaten. Ills. 3500 w. Engr, Lond —June 2, 1905. No. 70199 A.

Compression.

Tests upon the Influence of Compression upon Steam Engine Economy (Versuche über den Oekonomischen Einfluss der Kompression bei Dampfmaschinen). Dr. Herbert Klemperer. Discussing experiments made at the laboratory of the Dresden Polytechnic, showing the conditions under which compression may partially overcome the evils of clearance. 5000 w. Zeitschr d Ver Deutscher Ing—May 20, 1905. No. 70403 D.

Condensation.

Condensation Losses in Engine Cylinders. George T. Hanchett. Explains what is known as Hirn losses, gives the method of determining the economy of an engine by the use of the formula of Robert C. Heck, which gives satisfactory results. 1600 w. Cent Sta—June, 1905. No. 69973.

Corliss Engine.

1500-I.-H.-P. Corliss Engine for the Transvaal. Illustrated description of an engine recently built for the Premier Diamond Mining Co., Ltd., of the Transvaal. 700 w. Engng—May 19, 1905. No. 69911 A.

Exhaust Steam.

Utilization of the Exhaust Steam From Turbines. Franz Koester. A short illustrated description of the installation and operation of a steam turbine plant in a brewery at Rotterdam. 2000 w. Elec Wld & Engr—June 3, 1905. No. 70072.

Explosion.

The Brockton Boiler Explosion. A full illustrated account of the explosion in the factory of R. B. Grover & Co., manufacturers of the Emerson shoe. Also an explanation of the cause. 8000 w. Locomotive—April, 1905. No. 69937.

Feed Water.

System of Hot Feed Water for Stationary Boilers and Shop Heating. A. A. Mayer. Read before the Canadian Ry. Club. Illustrates and describes a system in use at the locomotive works of the Grand Trunk Ry., at Montreal. 1400 w. Dom Engng—June 3, 1905. No. 70033.

Firing.

The Firing of Babcock and Other Boilers by Waste-Heat from Coke-Ovens. T. Y. Greener. Gives details of evaporation tests of boilers attached to coke-ovens at various collieries, with descriptions of boilers, ovens, chimneys, etc. Discussion at London meeting of the Inst of Min. Engrs. 3500 w. Ir & Coal Trds Rev—June 2, 1905. No. 70202 A.

Indicating.

How to Indicate the Engine. George P. Pearce. Directions to aid a beginner in taking his first cards. 1500 w. Marine Engng—June, 1905. No. 70014 C.

Indicators.

Improved Indicators and Indicator Spring Testing (Indikator, Prüfungs-Einrichtung und Neuerungen an Indikatoren). A description of the spring-testing apparatus of the Dortmund Boiler Inspection Association, with illustrations of new outside-spring indicators. 1500 w. Glückauf—May 20, 1905. No. 70451 D.

Oil Burning.

Oil Burning in Steam Boilers. W. H. Fowler. Compares coal and petroleum as a fuel, discussing the properties of the latter, the method of burning, and related matters. Ills. 2500 w. Mech Engr —May 20, 1905. No. 69940 A.

Piping.

Notes on Steam Pipes (Betrachtungen über Dampfrohrleitungen). E. Kühne. A discussion of the stresses on steam pipes, both internal and external, including the arrangement of flexible and expansion joints. 1500 w. Schiffbau—May 10, 1905. No. 70459 D.

The Trap Return System at the United States Military Academy, West Point, N. Y. Illustrates and describes the method of taking care of the condensation in an extensive system of supply pipe, by the use of Bundy return and tank traps which all feed into a common return main. 1200 w. Power—July, 1905. No. 70394 C.

Separators.

The Separation of Moisture from Steam. R. T. Strohm. Explains why it is desirable to remove the moisture, and discusses methods of accomplishing the separation. Ills. 2300 w. Am Elect'n—June, 1905. No. 70006.

Steam Engines.

The Development of the Steam Engine in Germany (Die Einführung der Dampfmaschine in Deutschland). Conrad Matschoss. A historical review of steam engineering in Germany, with portraits of engineers and illustrations of old engines. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70407 D.

Steam Ploughs.

A Technical Study of Steam Ploughs (Ueber die Technische Untersuchung von Dampfpflügen). Josef Rezek. An account of practical tests made with a Fowler steam plow in northern Italy, showing the work accomplished for the fuel consumed. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 26, 1905. No. 70442 D.

Steam Trap.

Neilson's Steam Trap. Illustrates and describes a design in which the main delivery valve is operated by the energy of the steam. 700 w. Mech Engr—June 17, 1905. No. 70502 A.

Steam Turbine.

A Ten-Thousand Horse-Power Steam Turbine. Franz Koester. Illustration and description of the 10,000 horse-power Brown-Boveri-Parsons steam turbine at the Rhenanian-Westphalian electricity works, Essen, Germany. 1200 w. Power—July, 1905. No. 70392 C.

Steam Turbines in America. A review of the committee reports to the National Electric Light Assn. on the present condition of the steam turbine in the United States. 3500 w. Eng Rec—June 24, 1905. No. 70380.

Test of a 500 K.W. Turbine Generating Set at the Preussen Mine (Untersuchung einer 500 K.W. Turbodynamo für die Zeche Preussen I). F. Schulte. Tests of an A. E. G. turbine dynamo, showing a steam consumption of 23.7 pounds per kilowatt hour. 1200 w. Glückauf—May 20, 1905. No. 70450 D.

The British Thomson-Houston Works at Rugby. Editorial account of a visit to their works at Rugby and description of the Curtis turbine. 3000 w. Engng—May 19, 1905. No. 69947 A.

The De Laval Steam Turbine in America. John L. Mohun. An illustrated article recording the progress which has been made in the use of steam turbines for direct connecting to other machinery than electrical. 1800 w. Cassier's Mag—June, 1905. No. 69967 B.

Superheater.

The Schmidt Superheated Steam Locomotive. Emile Guarini. Illustrated description of an application of highly superheated steam to locomotives. 1000 w. R R Gaz—Vol. XXXVIII. No. 24. No. 70267.

The Use of Superheated Steam on Locomotives. H. H. Vaughan. Read before the Am. Ry. Mas. Mech. Assn. Reviews the history of the use of superheated steam, discussing briefly the theory and results, and giving conclusions. Ills. 10000 w. Ry & Engng Rev—June 17, 1905. No. 70287.

Traction Engines.

Accidents with Traction Engines. William Fletcher. Describes some of the roads these engines have to traverse, and relates accidents that have taken place. Ills. 1400 w. Prac Engr—May 19, 1905. No. 69938 A.

Vacuum.

The Effects of Vacuum on Steam-Engine Economy. R. M. Neilson. An illustrated review of central-condensing systems, cooling towers, and the auxiliary machinery of the condensing plant. Ills. 3600 w. The Engineering Magazine—July. Serial. 2nd part. No. 70485 B.

Valves.

Self-Closing Valves (Selbstschlussventile). R. Pöthe. Illustrating and describing a variety of automatic valves which act to shut off steam in case of explosions or breakages of pipes or mains. Three articles—4500 w. Schiffbau—April 26, May, 10, 24, 1905. No. 70158 each D.

The Drop Valve and Its Gear. An illustrated discussion of the design of drop valve gears, describing some early designs, and the changes. 2200 w. Engr, Lond—May 26, 1905. Serial. 1st part. No. 70123 A.

Valve Setting.

Setting Direct and Indirect Link Motion. H. H. Kelley. An illustrated article giving directions for setting both the direct and indirect link gears. 2300 w. Engr, U S A—June 15, 1905. No. 70281 C.

Water-Tube.

A New Water-Tube Boiler. Illustrated description of the Keeler water-tube boiler and superheater. 1200 w. Engr, U S A—June 1, 1905. No. 69981 C.

Water Softening.

Notes on Softening and Purification of Water for Steam Raising. Louis J. Le Clair. Abstract of a paper read before the Dublin Soc. of the Inst. of Elec. Engrs. Considers the causes of temporary and permanent hardness, and Dr. Clark's method of treating the water for hardness and methods of eliminating oil. 2800 w. Prac Engr—May 19, 1905. No. 69939 A.

MISCELLANY.

Aeronautics.

A Bird as a Model for the Aeroplane. Illustrated report of investigations by three British experimentalists, showing the apparatus used. 2000 w. Sci Am—July 1, 1905. No. 70540.

Lifting Experiments with a Helicopter (Experiences d'Enlevement d'un Helicoptère). S. A. S. le Prince de Monaco. Describing tests with the Léger machine.

having two propellers revolving in opposite directions on the same vertical axis. 1000 w. Comptes Rendus—May 15, 1905. No. 70432 D.

Recent Experiments with the Leger Helicopter (Nouvelles Expériences d'Enlèvement de l'Hélicoptère M. Leger). M. Léger. Experiments with lifting propellers, showing that a motor of 10 h. p. was capable of lifting 100 kg. in addition to its own weight. 1000 w. Comptes Rendus.—June 5, 1905. No. 70438 D.

Wing-Flight—Some Researches at Cambridge. An illustrated article giving interesting results of experiments. 2000 w. Auto Jour—May 27, 1905. No. 70105 A.

Aeroplane.

The Gillespie Aeroplane. Charles B. Hayward. Illustrates this aeroplane, and gives a brief description. 1700 w. Sci Am—June 24, 1905. No. 70349.

Crane.

Electrically Driven Locomotive Crane (Lokomotivkran mit Elektrischem Antrieb). C. Herrm. Findeisen. With details of hoisting and propelling mechanism, wiring, and control. 1200 w. Zeitschr d Ver Deutscher Ing—June 3, 1905. No. 70409 D.

Elevators.

Fundamental Features of Electric Elevators. E. R. Carichoff. The first of a number of articles which will cover the field of electric elevator service. The various systems will be described, the method of control, and the various safety devices. Ills. 2000 w. Elec Rev, N Y—June 24, 1905. Serial. 1st part. No. 70361.

Filter Presses.

Material Used in the Construction of Filter Presses. Emil Hatschek. A brief description of the materials available and employed in filter press construction. Ills. 900 w. Elec-Chem & Met Ind—June, 1905. No. 70091 C.

Oil Purification.

The Purification of Waste Lubricating Oil. F. H. Davies. Considers the extraction of mechanical impurities by filtration, illustrating methods. 1700 w. Can Elec News—May, 1905. No. 69955.

Tanks.

Cast-Iron Tanks. W. J. Jones. A discussion of tank design and construction, with illustrations. 8000 w. Public Works—April, 1905. No. 69932 F.

MINING AND METALLURGY

COAL AND COKE.

Alaska.

Petroleum and Coal Fields of the Pacific Coast of Alaska. George C. Martin. From the Geol. Surv. Bul. on this subject. An illustrated article giving information of these fields, their development, deposits, etc. 2500 w. Sci Am Sup—June 24, 1905. No. 70351.

Briquettes.

The Manufacture of Briquettes. Translated from *Der Stein der Weisen.* Explains the methods of forming both anthracite and bituminous briquettes, illustrating ovens used. 2000 w. Sci Am Sup—July 1, 1905. No. 70552.

Coal Fields.

The Coal Fields of Arkansas and Indian Territory. Carl Scholz. Brief illustrated description. The coals are bituminous and semi-anthracite. 1200 w. Min Mag—June, 1905. No. 70215 C.

The Concealed Coalfield of Yorkshire, Darbyshire, and Nottinghamshire. From the report by P. F. Kendall. Gives conclusions reached, and map, with a summary of the evidence for the boundaries. 3800 w. Ir & Coal Trds Rev—May 19, 1905 No. 69952 A.

Cumberland Gap.

The Cumberland Gap Coalfield. Notes from a monograph by J. C. Tipton, describing this field. 1300 w. Eng & Min Jour—June 15, 1905. No. 70273.

Electricity.

Electricity in German Collieries. E. O. Forster Brown. From a paper read before the Mining Institute of Scotland, giving a statement of the methods used in German collieries and the extent to which electricity has been adopted. 900 w. Eng & Min Jour—June 8, 1905. No. 70147.

Explosions.

Mine Explosions. J. T. Beard. Explosions due to excessive use of powder and other causes are discussed, and the energy developed in the combustion of powder and coal dust. 3000 w. Mines & Min—June, 1905. Serial. 1st part. No. 70082 C.

The Zeigler Mine Explosion. J. T. Beard gives the report of the Illinois State Mining Board with a brief description of results of the explosion. 2200 w. Mines & Min—June, 1905. No. 70080 C.

Filling.

The Conveyor-System for Filling at the Coal-Face, as Practiced in Great Britain and America. W. C. Blackett and R. G. Ware. Abstract of a paper before the Inst. of Min. Engrs., with discussion. 4700 w. Ir & Coal Trds Rev—June 9, 1905. No. 70317 A.

Lignite.

The Utilization of Slack in the Bohemian Lignite Mines (Die Verwertung der Kohlenlösche auf den Böhmischen Braun Kohlengruben). Wilhelm Schöndeling. A discussion of methods of briquetting and coking lignite slack and dust, from a commercial point of view. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—May 20, 1905. No. 70447 D.

Peat.

The Use of Low Value Fuels with Especial Reference to Peat (Die Verwertung Minderwertiger Brennstoffe insbesondre des Torfes). Hr. Gercke. A discussion of the various methods of preparing peat as fuel, and the best appliances for burning it. 3000 w. Zeitschr d Ver Deutscher Ing—May 27, 1905. No. 70413 D.

Queensland.

Central District Coal Measures. Walter E. Cameron. A report of field work with the object of tracing the continuation of these coal measures towards the Mackay and Nebo districts. Map. 3000 w. Queens Gov Min Jour—April 15, 1905. Serial. 1st part. No. 69953 B.

Safety Lamps.

New Safety Lamps Authorized for Use in Belgian Mines. V. Watteyne and S. Stassart, in *Annales des Mines de Belgique*. Illustrated description. 800 w. Col Guard—May 26, 1905. No. 70116 A.

Shot-Firing.

Some Suggestions on Shot-firing. Suggestions made by A. L. Hayden to the Kansas Commission on accidents in coal mines. 1200 w. Eng & Min Jour—June 15, 1905. No. 70275.

Underground Fires.

The Occurrence of Underground Fires at the Greta Colliery, New South Wales. J. Jeffries. Abstract of a paper read before the Inst. of Min. Engrs. Gives the writer's opinion of the cause of the fires. 2200 w. Ir & Coal Trds Rev—June 9, 1905. No. 70318 A.

COPPER.

Arizona.

In the Chiricahuas-Cochise County, Arizona. Brief description of the development of properties in Paradise Camp, recently attracting attention for the copper deposits. Ills. 1400 w. Min Rept—June 22, 1905. No. 70375.

Assay.

The Iodimetric Determination of Copper. T. Brown, Jr. A discussion of the methods used. 1400 w. Eng & Min Jour—June 8, 1905. No. 70151.

Concentration.

Concentration of Copper Ore. Frank H. Probert. An illustrated article giving results of experiments at Arizona mines, concerning the economical concentration of low grade copper ore. 2000 w. Eng & Min Jour—June 8, 1905. Serial. 1st part. No. 70149.

Cyanidation.

Ammonia Cyanidation of Copper. Abstracted from the discussion of the paper by Jarman and Brereton. 3300 w. Eng & Min Jour—June 22, 1905. No. 70366.

Utah.

Ore deposits of Bingham, Utah. J. M. Boutwell. An illustrated account of this copper producing camp, its geology, ores, etc. 2200 w. Eng & Min Jour—June 22, 1905. No. 70364.

Ore Deposits of Bingham, Utah. J. M. Boutwell. Descriptive account. 2200 w. Min Wld—June 17, 1905. No. 70284.

Vancouver.

Copper Property at East Sooke, Vancouver Island. Report of this property, its geology, characteristics, developments, &c., by W. M. Brewer. 1700 w. B C Min Rec—May, 1905. No. 69957 B.

GOLD AND SILVER.

Amalgamation.

Amalgamating Gold Ores. Algernon Del Mar. Gives the writer's ideas, based upon western experience. 2000 w. Min & Sci Pr—June 10, 1905. No. 70276.

Assaying.

Correcting an Error in the Fire Assay. Charles Finley Easton. Gives experiments and details of operations in the use of a method explained in detail in an earlier article. 2000 w. Min Rept—June 22, 1905. No. 70377.

China.

The Tien Pan Shan Mines. John C. Shengle. Illustrated description of the Chinese method of working these silver mines. 700 w. Eng & Min Jour—June 1, 1905. No. 70027.

Concentration.

The Jackson Concentrating Works, Idaho Springs, Colorado. C. M. Rath and R. L. Grider. Describes the mill and the treatment of the ore. 1500 w. Min Rept—June 1, 1905. No. 70044.

Cyanide.

Cyanidation at Cripple Creek. G. E. Wolcott. Gives information concerning the methods of the Homestake company. 1200 w. Eng & Min Jour—June 8, 1905. No. 70148.

The Cyanide Process. From a treatise from the Redwood Mfrs. Co., San Francisco, Cal., written by Mr. Brown. A description of the cyanide process and some points governing the construction of cyanide plants. 3000 w. Min & Sci Pr—May 27, 1905. Serial. 1st part. No. 69999.

Dredging.

Dredging for Gold in British Columbia. Notes from the annual report of the Minister of Mines. 2800 w. B C Min Rec—June, 1905. No. 70530 B.

The Twentieth-Century Gold Ships and their cargoes. Alex Del Mar. A graphic statement of the progress and possibilities of gold dredging, the general requirements of dredge construction and operation, and the prospective effect on the world's output of gold. Ills. 3000 w. The Eng Mag—July, 1905. No. 70480 B.

Homestake.

Discovery and Development of the Homestake Mines of South Dakota. Historical review, with illustrations of these famous gold mines, and the methods of working them. 4000 w. Min & Sci Pr—June 17, 1905. Serial. 1st part. No. 70353.

Lime.

Notes on Lime, Clean Up, etc. Gerard W. Williams. Gives methods of determining the available caustic lime in a sample, showing that the efficacy of lime for the purposes for which it is employed in cyanide works is more than directly proportional to the percentage of free lime. Also a method of determining the percentage of free acid in the solutions from the acid treatment of zinc. 3500 w. Jour Chem, Met. & Min Soc of S Africa—April, 1905. No. 70303 E.

Mount Lyell.

Mount Lyell Mining Field. Prof. J. W. Gregory. The present number describes the geology and character of this Australian mining district. 2800 w. Aust Min Stand—April 26, 1905. Serial. 1st part. No. 70103 B.

Nevada.

Goldfield District, Nevada. Illustrated description of the geology of this district, as given by J. E. Spurr, in Bul. 260, U. S. Geol. Survey. 2500 w. Min & Sci Pr—June 17, 1905. No. 70354.

Nicaragua.

Mining in Nicaragua. H. E. West. An illustrated account of the mining industry which is confined to gold and silver mining. 2000 w. Min Mag—June, 1905. No. 70213 C.

Placers.

The Origin and Classification of Placers. H. L. Smyth. Aims to show how the distribution and concentration of the valuable particles in placers are dependent on the conditions under which erosion, transportation and deposition takes place. 2000 w. Eng & Min Jour—June 1, 1905. Serial. 1st part. No. 70032.

Queensland.

The Gympie Goldfield. F. Danvers Power. An illustrated description of this field, which is the third largest producer in Queensland, with an account of its discovery. 1800 w. Eng & Min Jour—June 1, 1905. No. 70030.

Refining.

Refining Gold Bullion and Cyanide Precipitates with Oxygen Gas. T. Kirk Rose. Discusses the action of oxygen and of nitrogen, on molten metals, and on mixtures, the treatment, methods, etc. 1500 w. Inst of Min & Met—April 13, 1905. No. 70212 D.

Santo Domingo.

Gold in Santo Domingo. F. Lynwood Garrison. An illustrated article describing this island and reviewing what is known of its geology and gold ores. 2700 w. Eng & Min Jour—June 15, 1905. No. 70272.

Slimes.

The Moore Process. C. H. Fulton. Information concerning the improved Moore slime-filter and the results obtained. 1100 w. Eng & Min Jour—June 1, 1905. No. 70029.

Smelter.

A New Pyrite Smelter. Herbert Haas. Illustrated description of the copper smelter of the Great Western Gold Co., at Ingot, Col. 1200 w. Eng & Min Jour—June 8, 1905. No. 70146.

Sulphides.

The Treatment of Refractory Auriferous Sulphides at the Cassilis Mine, Victoria, Australia. Francis B. Stephens. Read before the Inst. of Min. & Met. Describes the ore and the methods of treatment, giving costs. 4000 w. Min Jour—June 3, 1905. No. 70193 A.

Tonopah.

Geology of Tonopah District, Nevada. Information from the latest report of J. E. Spurr, as given in Bulletin 260 of the U. S. Geological Survey. 3000 w. Min & Sci Pr—June 10, 1905. No. 70277.

Transvaal.

The Gold Bearing Reefs of the Murchison Range Districts, Transvaal. Hans Merensky. A report with special consideration of the ore deposits of the Free State, Blue Jacket, and Lawrence mines. Ills. 3000 w. Min Jour—June 10, 1905. No. 70308 A.

Values.

Table of Assay and Coinage Values for Gold. R. J. Holland. Tables with explanation. 2500 w. Min Mag—June, 1905. No. 70216 C.

Washington.

The St. Helena Mining District. Harvey W. Bailey. Information concerning this district in the Pacific north-west, where gold, silver, lead, iron, copper, zinc and other valuable minerals are found. 2300 w. Ills. Min Wld—June 3, 1905. No. 70034.

IRON AND STEEL.

Blast Furnaces.

The Detroit Iron and Steel Company's Blast Furnace Plant. Illustrated description of these works and their equipment. 1400 w. Ir Age—June 1, 1905. No. 69958.

The Zug Island Furnace of the Detroit Iron and Steel Co. Illustrated detailed description of the blast furnace especially designed for the production of foundry pig iron. 2500 w. Ir Trd Rev—June 1, 1905. No. 69982.

Dry Air Blast.

Dry Air Blast and Turbine Blowing Engines. Abstract translation of an article by Prof. Mathesius, in *Stahl und Eisen*, describing a new method of drying the blast. 2000 w. Ir Age—June 1, 1905. No. 69960.

The Use of Dry Air in Blast Furnaces. Articles by A. Pourcel, and O. Boudouard, translated from *Revue de Metallurgie*. 1800 w. Ir & Steel Mag—June, 1905. No. 70225 D.

Electric Driving.

The Electric Driving of Rolling Mills. Brief illustrated account of two modern German rolling mills equipped electrically. 900 w. Elect'n, Lond—June 16, 1905. No. 70506 A.

Electric Smelting.

The Present Status of Electric Smelting of Iron and Steel (Der Gegenwärtige Stand der Elektrischen Eisen und Stahl Eszengung). Dr. H. Borchers. An examination of the commercial operation of existing processes, holding them all to be yet in the experimental stage. 2000 w. Zeitschr d Ver Deutscher Ing—June 10, 1905. No. 70418 D.

Ferro-Vanadium.

Manufacturing and Metallurgy ot Ferro-Vanadium. J. Baxeres de Alzugaray. Information about the properties this alloy imparts to iron and steel, and the progress made by this new industry. 1600 w. Min Wld—June 4, 1905. No. 70371.

Puddling.

The Roe Mechanical Puddling Process. Joseph Hartshorne. Describes this process and the recent improvements introduced. 3800 w. Ir Age—June 15, 1904. No. 70211.

Sulphur.

The Determination of Sulphur in Iron Ores. J. Howard Graham. Work undertaken to test statements made by Williams, and to determine the influence of ammonium chloride, hydrochloric acid, and ferric chloride in solution, on the precipitation of barium sulphate. 3300 w. Jour Fr Inst—June, 1905. No. 70219 D.

Vanadium.

Vanadium and Vanadium Steel. Gives a résumé of the methods by which this metal has been extracted from its ores, and discusses the properties of the vanadium steels. 2500 w. Engr, Lond—June 9, 1905. No. 70309 A.

MINING.

Boring.

Methods and Appliances for Deep Boring (Kurze Uebersicht der Verfahren und Einrichtung zum Tiefbohren). Paul Stein. A general review of deep boring and prospecting practice in Germany, with illustrations of machinery and tools. Two articles. 4500 w. Glückauf—May 20, 27, 1905. No. 70449 each D.

Cage Chains.

German Types of Cage Chains. Illustrates both favorable and unfavorable types, with a discussion of causes of accidents. 900 w. Col Guard—June 16, 1905. No. 70509 A.

Dislocations.

Simultaneous Joints. George F. Becker. Discusses the systems of joints of simultaneous origin, found distributed over rock exposures, etc. 3300 w. Eng & Min Jour—June 22, 1905. No 70305.

Drill Sharpening.

The "Ajax" Rock-Drill Sharpener. Illustrated description, with a comparison of the cost of hand and machine sharpening. 600 w. Engng—May 19, 1905. No. 69945 A.

Electric Winding.

Electrically-Driven Winding Engines. Remarks on the selection of a system and type of motor, with brief descriptions of some installations erected by the Allgemeine Elektricitäts-Gesellschaft, Berlin. Ills. 2500 w. Elec Engr, Lond—June 2, 1905. No 70189 A.

Explosions.

See Mining Engineering, Coal and Coke.

Fissure Veins.

Fissure Veins and Ore Deposits as Waterways. Arthur Lakes. An illustrated article explaining some of the evidences that these veins are, or have been, water carriers. 1800 w. Min Wld—June 24, 1905. No. 70370.

Haulage.

A complete Electrical Installation Underground. Brief illustrated description of the electrical plant at the United National Collieries, Rhondda Valley, South Wales. 1700 w. Col Guard—May 26, 1905. No. 70115 A.

Head Frames.

The Rational Design of Head Frames for Mines. George S. Binckley. An illustrated article which the writer offers for consideration. 1200 w. Min & Sci Pr—June 10, 1905. No. 70278.

Hoisting.

Hoisting Rope Connections (Förderkorb-Zwischengeschirre). H. Eigen. An illustrated discussion of the best methods of attaching wire hoisting ropes to cages and buckets. 1500 w. Glückauf—May 27, 1905. No. 70452 D.

The Commercial Selection of Hoisting Ropes (Beitrag zur Wirtschaftlichen Wahl von Förderseilen). Ernst Schmid. An examination of winding ropes for mines with diagrams enabling a selection to be made according to the depth, load and quality. Two articles. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—May 27, June 3, 1905. No. 70448 each D.

See also Winding.

Mineral Zone.

The International Mineral Zone. Horace F. Evans. Begins a discussion of some of the problems of the region on the boundary between the United States and British Columbia. 1200 w. Min Wld—June 5, 1905. Serial. 1st part. No. 70035

Mine Surveying.

Henderson's Rapid Traverser. Herbert Perkin. An illustrated description of the instrument and the method of using, discussing the conditions under which its use is of advantage. 1200 w. Mines & Min—June, 1905. No. 70081 C.

Power.

Central Power Stations for Mines. An account of an innovation being introduced in South Africa, with report of cost. 3500 w. Engr, Lond—June 2, 1905. No. 70198 A.

Power for Coal Mining Machinery. G. E. Lynch. Considers the relative efficiencies and advantages of compressed air and electricity, and the machines and uses to which each is adapted. Ills. 4000 w. Mines & Min—June, 1905. No. 70079 C.

Separator.

The Blake-Morscher Electrical Ore Separator. A. M. Plumb. An account of the application of this process to the complex ores of the old Galena district in Illinois and Wisconsin. Ills. 1600 w. Min Mag—June, 1905. No. 70214 C.

See also Electrical Engineering, Electro Chemistry, Concentration.

Sinking-Pump.

Electrically-Driven Turbine Sinking-Pump. Illustrated description of a mine pump of English manufacture. 800 w. Engng—May 26, 1905. No. 70121 A.

Timbering.

Shaft Timbering at the Kennedy Mine. F. J. Girard. Illustrates and describes methods used in the deepest mine in California. 900 w. Min & Sci Pr—May 27, 1905. No. 69998.

Winding.

Electric Winding Engines (Les Machines d'Extraction Electriques). H. Schmerber. With illustrations and details of a number of electrically operated hoisting engines for mines in France and Germany. Two articles, two plates. 6000 w. Génie Civil—May 27, June 3, 1905. No. 70424 each D.

1500-Horse-Power Winding Engine at the Liege Exhibition. Illustrated description of an engine with two horizontal twin cylinders, driving a shaft on which are keyed two winding drums for flat fibre cables. 900 w. Engng—June 16, 1905. No. 70512 A.

See also Hoisting.

MISCELLANY.

Cuba.

Notes on Cuba. W. J. Morgan. An illustrated article giving information of roads and railroads, climate, soil, etc. 1800 w. Ry & Loc Engng—June, 1905 No. 70092 C.

Kaolin.

Kaolin, or China Clay. J. H. Collins. Describes the deposits and methods of working. 2000 w. Eng & Min Jour——June 8, 1905. No. 70145.

Mexico.

Thirty Days of a Mining Engineer's Life in Mexico. E. A. H. Tays. An interesting account of difficult traveling in the mining districts. Ills. 4000 w. Min & Sci Pr—June 3, 1905. Serial. 1st part. No. 70175.

Oil Fields.

The Muscogee Oil Fields. H. B. Conner. An account of a recent discovery in

Indian Territory. 1400 w. Min Wld—June 17, 1905. No. 70283.

Peru.

Peru. Russell T. Mason. A sketch of the mining progress and conditions. The ores are principally copper, silver, lead and coal is also found. 3000 w. Eng & Min Jour—June 8, 1905. No. 70150.

Philippines.

The Mineral Resources of the Philippines. Nearly full report of Capt. H. D. McCaskey, concerning the mineral resources of the islands, giving a summary of information available to date. 3500 w. Eng & Min Jour—June 1, 1905. No. 70031.

Quicksilver.

Chinese Methods of Mining Quicksilver. Henry Brelich. Describes the methods in the Wan Shen Chang mines, showing how they make a living by mining low grade ore in the most antiquated way, and smelting it with the most primitive appliances. Ills. 2500 w. Min Jour—May 27, 1905. Serial. 1st part. No. 70113 A.

Rubies.

The Artificial Production of Rubies. Translated from *La Nature*. Describes the production of rubies by fusion. Ills. 1200 w. Sci Am Sup—June 3, 1905. No. 69995.

Semi-Precious Stones.

The Semi-Precious Stones of the United States. E. A. Reed. Information concerning agates moss agates, agatized wood, tourmaline, amazon stone, bloodstone, chrysoprase, and others. 3500 w. Min & Sci Pr—June 3, 1905. No. 70176.

Tin.

The Search for Tin. Gives a summary of places in the United States where tin ore is known to have been found, with a brief description of the mode of occurrence and means for determining the mineral. 1500 w. Min Rept—June 22, 1905. No. 70376.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

High Speeds.

High-Speed Railway Trains in Germany (Essais de Trains à Marche Rapide en Allemagne). Describing trials of steam locomotives on the Marienfelde-Zossen military railway, showing that speeds of 120 kilometres per hour were readily attained. 1800 w. Génie Civil—June 3, 1905. No. 70427 D.

Train Operation.

Points to be Observed by Enginemen While in Service in Order to Successfully Meet Modern Methods of Freight and Passenger Train Operation. W. T. Hurley. Reviews the methods of successful engineers. Discussion. 8500 w. Pro Cent Ry Club—May, 1905. No. 70322 C.

MOTIVE POWER AND EQUIPMENT.

Accounting.

Rational Locomotive Repair Records. H. H. Vaughan. Discusses the various factors entering into the maintenance of locomotives account, and explains method giving statement showing the cost of running repairs. 5500 w. Am Engr & R R Jour—June, 1905. No. 70019 C.

Brakes.

Maximum Brake Force as Regards Foundation Brake for Passenger and Freight Cars. F. M. Nellis. Read before the Air Brake Assn., at New Orleans. Discusses the new system of unbraked weight per car axle. 2200 w. Ry & Engng Rev—June 10, 1905. No. 70180.

Cars.

Combination, Box and Tank Car. Brief illustrated description. 500 w. R R Gaz—Vol. XXXVIII. No. 24. No 70263.

Framing of Passenger and Freight Cars. C. A. Seley. From an address before the students of Purdue Univ. Reviews the development and present practice in Europe and America. 4800 w. Ry & Engng Rev—June 10, 1905. No. 70178.

New York Central Steel Underframe Gondola Car. Illustrates and describes new cars which show original features of design. 600 w. Ry Age—June 23, 1905. No. 70360.

Counterbalancing.

Balancing Balanced Compound Locomotives. Gives method of counterbalancing revolving parts on a crank axle. Ills. 500 w. Am Engr & R R Jour—June, 1905. No. 70024 C.

Counterbalance for Balanced Compound Locomotives. Lawford H. Fry. Illustrations showing the position of the counterbalance, with explanation of the reason. 600 w. R R Gaz—Vol. XXXVIII. No. 23. No. 70163.

Draft Gear.

Friction Draft Gear. R. H. Blackall. Discusses the special advantages, uses and cost, and gives comparative results of twin and friction gears in service. 3000 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70260.

Relative Efficiency Tests of Friction and Spring Draft Gear. Illustrated description of testing machine and tests made at the Appliance Exhibition in Washington. 600 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70161.

Dynamometer.

Dynamometer Car. Drawings and description of a new car on the New York Central lines. 600 w. Am Engr & R R Jour—June, 1905. No. 70020 C.

Electric Locomotive.

See Street and Electric Railways.

Electric Traction.

See Street and Electric Railways.

Freight Cars.

Standard Freight Cars on the Pennsylvania Railroad. Illustrates and describes the various types. 2500 w. Ry & Engng Rev—June 17, 1905. No. 70286.

Locomotive Performance.

Locomotive Performance Under a Steam Pressure of 250 Pounds. W. F. M. Goss. An account of an investigation conducted under the patronage of the Carnegie Institution. 1800 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70167.

Performance of Mallet Compound Locomotive. Report of J. E. Muhlfeld, general superintendent of motive power of the B. & O., giving information in regard to the performance of the articulated duplex compound locomotive, No. 2400, which was exhibited at St. Louis. 1200 w. Am Engr & R R Jour—June, 1905. No. 70023 C.

Performance of the Baltimore and Ohio Ry.'s Mallet Compound Locomotive in Service. Illustration, with report of the working, coal consumption, road record, &c. 1200 w. Eng News—June 15, 1905. No. 70240.

Locomotives.

A French Locomotive with Water-Tube Boiler. Describes a locomotive, designed by Jacques Robert, for the Algerian division of the Paris, Lyons & Mediterranean Ry. Ills. 500 w. Eng News—June 15, 1905. No. 70239.

A New Design for a Four-Cylinder Balanced Compound Locomotive. Samuel F. Prince. A description of the writer's four-cylinder balanced system. Ills. 700 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70162.

An Old High-Speed Locomotive. Herbert T. Walker. Historical sketch and illustrated description of the "Cornwall," first built in 1847. and rebuilt in 1858. It is running to-day. 1700 w. Sci Am—June 10, 1905. No. 70170.

Common Standard Locomotives. Illustrates and describes details of the standard locomotives for the Harriman lines. 1000 w. Am Engr & R R Jour—June, 1905. No. 70021 C.

Compound Freighter for the Central Vermont. Illustration, description, and principal dimensions. 500 w. Ry & Loc Engng—June, 1905. No. 70093 C.

Express Locomotive for the Cambrian Railways. Illustrates and describes some fast and powerful four-coupled leading bogie locomotives for conveying mails and tourist traffic. 400 w. Engng—May 26, 1905. No. 70120 A.

Four Cylinder Compound Locomotive, G. N. R. Illustrates and describes one of a new series of Atlantic type locomotives recently put into service on the Great Northern Ry. 500 w. Engr, Lond—May 19, 1905. No. 69951 A.

Heavy Passenger Locomotives for the C. M. & St. P. Detail drawings and description of some heavy Pacific type passenger locomotives recently placed in service. 500 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70168.

New York Central Simple Consolidation Engine. Illustration, with description, of an engine on exhibition at Washington, during the International Railway Congress. It has the Walschaert valve gear. 700 w. Ry Mas Mech—June, 1905. No. 70159.

Pacific Type Engine with Superheater, Erie Railroad. Illustrated description of an engine designed to meet hard conditions of service. 700 w. Ry Mas Mech—June, 1905. No. 70158.

Standard Locomotives of the Pennsylvania Railroad. Examines the standard locomotive equipment of this road in the passenger, freight, and switching service. Ills. 2000 w. Ry & Engng Rev—June 10, 1905. No. 70179.

Tests of a Heavy Shay Locomotive. Illustration of a locomotive of the Shay type recently put in service on the Chesapeake & Ohio, with a description of its work as a hill-climber. 500 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70166.

The Development of the Mountain Locomotive (Die Entwicklung der Gebirgslokomotive). Dr. Rudolf Sanzin. An illustrated review of the successive improvements in steam locomotives for use on heavy grades, with especial reference to adhesion engines of Continental design. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 19, 1905. No. 70441 D.

The New Jungfrau Locomotive. Emile Guarini. Illustrates an old and a new Jungfrau locomotive, describing the latter in detail. 1400 w. Sci Am Sup—June 10, 1905. No. 70171.

Oscillations.

The Oscillations of Locomotives under the Perturbing Action of Various Forces (Oscillations des Locomotives sons l'Action de Diverses Forces Perturbatrices). Georges Marié. A study of the influence of inertia and centrifugal forces upon the oscillations of locomotives. 1200 w. Comptes Rendus—May 29, 1905. No. 70434 D.

Postal Car.

Steel Underframe Postal Car for the Santa Fe. Drawings and description. 700 w. R R Gaz—Vol. XXXVIII., No. 24. No. 70261.

Repairs.

Manufacture of Material at a Repair Point. W. F. Jones. Discusses the question from the point of economy and the retaining of men in the dull season. General discussion. 2500 w. Pro Cent Ry Club—May, 1905. No. 70323 C.

Rolling Stock.

South-Eastern and Chatham Railway New Rolling Stock. Illustrates and describes some new first-class passenger saloons and coaches. 900 w. Engr, Lond —May 26, 1905. No. 70125 A.

Shop Practice.

A Large Locomotive-Building and Repair Works in France. C. R. King. An illustrated account of the Epernay Shops of the Est Railway, especially of the general machine-tool equipment and methods. Ills. 3500 w. The Engineering Magazine —July, 1905. Serial. 1st part. No. 70481 B.

Stoker.

The Victor Stoker. Illustrated detailed description of this locomotive stoker, with report of a trip on an engine fitted with it. 3500 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70165.

Superheating.

Superheating Locomotives. Rudolf Vogdt in *Die Umschau.* States briefly the advantages of superheated steam, giving illustrations of several types of locomotive superheaters, and information concerning their use. 1000 w. Sci Am Sup—June 10, 1905. No. 70174.

Test of a Superheater Locomotive. Gives interesting results of a test on the Chicago & Northwestern with superheater locomotives to determine their relative efficiency. 800 w. R R Gaz—Vol. XXXVIII., No. 23. No. 70160.

See also Mechanical Engineering, Steam Engineering.

Valve Gear.

Walschaert vs. Stephenson Valve Gear A comparison showing the saving in weight by using the Walschaert gear, and giving other facts. Also editorial. 1700 w. Am Engr & R R Jour—June, 1905. No. 70022 C.

NEW PROJECTS.

Mexico.

Mexican Railroads for Mine Development. George E. Walsh. An interesting article showing the intimate connection between the railroads and the mining industries, which are being rapidly developed. 2400 w. Ry Age—June 23, 1905. No. 70359.

New Line.

The San Pedro, Los Angeles & Salt Lake Ry. Reviews the history of the undertaking, recently completed, and gives information concerning the road. Map and cross-sections are given. 1500 w. Eng News—June 22, 1905. No. 70347.

PERMANENT WAY AND BUILDINGS.

Coaling.

Holmen Coaling Station, Pennsylvania Lines. Illustrated detailed description of a type of coaling station being installed at many places on the lines west of Pittsburg. 700 w. Ry Age—June 9, 1905. No. 70129.

Coaling Plant.

The Locomotive Coaling Plant at the Grunewald Station in Berlin (Anlage zur Lokomotivbekohlung auf Bahnhof Grunewald in Berlin). M. Buhle. Illustrated description of a coal pocket and handling plant for railway service. 1000 w. Zeitschr d Ver Deutscher Ing—May 13, 1905. No. 70402 D.

Curves.

The Oscillation of Cars upon Entering and Leaving Curves (Oscillations des Véhicules de Chemin de Fer à l'Entrée en Courbe et à la Sortie). Georges Marié. Deriving equations for computing the oscillations of cars, with suggestions for the improvement of curves and way. 1200 w. Comptes Rendus—May 8, 1905. No. 70430 D.

New Orleans.

The New Orleans Terminal Company. An illustrated detailed description of improvements in the terminal facilities of the New Orleans & Northeastern R. R. 2000 w. Ry Age—June 23, 1905. No. 70358.

Reinforced Concrete.

Reinforced Concrete Structures for Railroads. A. O. Cunningham. States the advantages of this material, discussing some of its applications, especially to bridge construction, and particulars in regard to the systems, with stresses, &c. 3000 w. Ills. Trans Assn of Civ Engrs of Cornell Univ—1905. No. 70543 F.

Resistance.

Train Resistance in Relation to the Track. P. H. Dudley. Reviews the reduction in train resistance and the factors that have most contributed to improvement, studying the effect of the distribution of loads, and the condition of tracks. 4500 w. Harvard Engng Jour—June, 1905. No. 70208 D.

Shops.

Fire Protection in Railroad Shops. H. S. Knowlton. Suggestions concerning means that should be taken to guard against fire. 1800 w. Ry Age—June 9, 1905. No. 70128.

Side-Leveler.

A Contractor's Side-Leveler. George W. Lee. Illustrates and describes a very useful mcahine in roadbed construction, which can be quickly built at moderate cost. 800 w. Eng News—June 15, 1905. No. 70236.

Signaling.

Electrical Features of Block Signaling. L. H. Thullen. Gives a brief sketch of the older methods of signaling, and an illustrated description of the modern electric signals. 2400 w. Am Inst of Elec Engrs—June, 1905. No. 70248 D.

Track.

What Will Be the Future Railway Track for Heavy Traffic? Editorial discussion of this subject, quoting from an editorial in the *R. R. Gazette.* 2800 w. Eng News—June 8, 1905. No. 70101.

Train Shed.

The Platform Shelters of the New Lackawanna Terminal at Hoboken. Brief illustrated description of the proposed shed, which consists of a number of low, short-span, longitudinal sections, with the steel protected by concrete. 1000 w. Eng Rec—June 24, 1905. No. 70381.

Yards.

Arrangement and Operation of American Freight Yards. George L. Fowler. Illustrated description of the West Albany yard of the New York Central, and the method of operation. 4200 w. R R Gaz—Vol. XXXVIII., No. 22, No. 69989.

TRAFFIC.

Clearing System.

A Glance at the Railway Clearing House of England—Can the Plan Be Profitably Followed in America? J. W. Midgley. An explanation of the system and of the conditions in England. 3500 w. Ry Age—June 16, 1905. No. 70280.

Rates.

Both Sides of the Rate Regulation Discussion Restated. Gilson Gardner. A statement of the arguments presented in the joint debate carried on in Washington. 3300 w. Ry Age—June 16, 1905. No. 70279.

MISCELLANY.

Inter-Oceanic.

Jubilee of the First Inter-Oceanic Railway. An interesting review of the building of the Panama Railway, completed in 1855. 2000 w. Engr, Lond—June 9, 1905. No. 70313 A.

STREET AND ELECTRIC RAILWAYS

Berlin-Zossen Tests.

The Berlin-Zossen Tests and Their Results. Abstract of an address by Charles A. Mudge, at a meeting of the N. Y. Elec. Soc. Describes the apparatus installed in the Allgemeine car, giving report of tests, and other information of interest. Ills. 3500 w. St Ry Jour—June 3, 1905. No. 70051 C.

Calcutta.

The Calcutta Tramways System. An illustrated detailed description of the electric traction system, with an account of the conditions under which it operates. 5500 w. St Ry Jour—June 3, 1905. No. 70046 C.

The Calcutta Tramways System. Illustrated description of electrification of the tramways system, and a statement of the climatic conditions which cause difficulty in operation. 4000 w. Elect'n, Lond—June 9, 1905. No. 70307 A.

Chicago Subway.

Building the Chicago Subway. William Hard, in *Public Opinion.* An account of the carrying out of this project; with a brief comparison with the methods of the New York subway. 3000 w. R R Gaz—Vol. XXXVIII., No. 22. No. 69988.

Conduit Line.

A Novel Conduit Line. Brief illustrated description of the new electric conduit line of Bastille-Charenton. 1500 w. Sci Am Sup—June 3, 1905. No. 69996.

Consolidation.

Saginaw & Bay City Railway & Light Co. An illustrated article describing a consolidation of four properties in Michigan, to be operated under one management. 3500 w. St Ry Rev—June 15, 1905. No. 70288 C.

Electric Locomotive.

The New Electric Locomotive for the

Valtellina Road. Illustrated detailed description of this new locomotive. The design of the motor and the method of control are of special interest. Also editorial. 4000 w. Elec Rev, N. Y.—June 24, 1905. No. 70362.

Weight Distribution on Electric Locomotives as Affected by Motor Suspension and Draw-Bar Pull. S. T. Dodd. The discussion is limited particularly to locomotives drawing trailing loads. Ills. 3500 w. Am Inst of Elec Engrs—June, 1905. No. 70250 D.

Westinghouse Single-Phase Electric Locomotive. Illustration and description of an electric locomotive weighing 135 tons for heavy electric traction. 800 w. R R Gaz—Vol. XXXVIII., No. 22. No. 69990.

Electric Traction.

Electric Traction on Railways. Discusses the main points which are essential for success of electric traction on railways, and reviews briefly the various alternating-current motors which have been tried on a large scale. 6000 w. Engng—May 26, 1905. No. 70118 A.

Light Electric Railways. James R. Cravath. From a paper before the Chicago Branch of the Am. Inst. of Elec. Engrs. Sets forth the demand for railways which can be built and operated cheaply for farming districts and small villages. Plans the type of road that will thrive, advocating narrow gage. Also editorial criticism. 2500 w. Eng News—June 29, 1905. No. 70537.

Electrification.

The Electrification of the Metropolitan District Railway. The present article gives principally an illustrated description of the rolling-stock and of the signaling system. 3000 w. Elec Rev, Lond—June 2, 1905. Serial. 1st part. No. 70191 A.

Elevated Construction.

Elevated Construction in Paris and Berlin. John P. Fox. An illustrated article discussing the ballasted construction adopted on the Berlin Stadtbahn, and the ballasted floor of the Paris Metropolitan Railway, and other possible improvements on elevated lines. 1500 w. St Ry Jour—June 24, 1905. No. 70372 C.

Grades.

The Computation of the Maximum Effective Incline for an Electric Railway (Rechnerische Bestimmung der Günstigen Maximalen Steigung für Elektrische Bahnen). Henri Somach. Deriving formulas and curves based upon the adhesion, tractive power, length of road, speed, and other operative conditions. 2000 w. Elektrotech Zeitschr—May 18, 1905. No. 70466 B.

Heavy Traction.

Heavy Traction Problems in Electrical Engineering. Carl L. de Muralt. Considers only problems relating to traction on through lines. 9000 w. Am Inst of Elec Engrs—June, 1905. No. 70254 D.

Interurban.

Electric Railway Developments. Prof. Horace T. Eddy. A general review of developments, especially of interurban lines, and the displacement of steam equipment. 2500 w. Sci Am—July 8, 1905. No. 70618.

London Tubes.

Baker Street and Waterloo Railway. Illustrated detailed description of the construction and equipment of this London tube line. 8000 w. Tram & Ry Wld—June 8, 1905. No. 70396 B.

Motorman's School.

A Motorman's School System in Brooklyn. An illustrated article explaining an interesting system for instructing new motormen for service on surface lines. 3500 w. St Ry Jour—June 17, 1905. No. 70270 C.

Nürnberg.

The Three-Wire Feeder System of the Electric Railway between Nürnberg and Fürth (Die Stromversorgung der Nürnberg Fürther Strassenbahn nach dem Dreileitersystem). Ph. Scholtes. With plan of the line and diagrams showing the change from the two-wire to the three-wire system. 2000 w. Elektrotech Zeitschr—May 25, 1905. No. 70467 B.

Overhead Lines.

On the Use of Aluminium for Overhead Power Lines. W. B. Esson. Gives facts in proof of the opinion that aluminium conductors are not, generally speaking, superior to copper conductors. 2000 w. Elect'n, Lond—June 2, 1905. No. 70187 A.

Ownership.

Contrasts Between Company and Municipal Ownership and Management of Public Utilities. H. W. Blake. Read before the Gt. Ry. Assn. of the State of N. Y. Discusses the general plans for maintaining public utilities, especially as practised in America, favoring private companies rather than municipal ownership. 4500 w. St Ry Jour—July, 1905. No. 70576 C.

Petaluma.

The Petaluma and Santa Rosa Railway. An illustrated description of a road built primarily for the handling of all kinds of express and freight, but also developed for passenger business. 1600 w. St Ry Jour—July 1, 1905. No. 70574 C.

Physical Tests.

Uniform Standards of Examination of Railway Employees. Dr F H. Peck

Read before the St Ry Assn of the State of N. Y. Deals with the medical tests made of vision, hearing, physical, health, etc. 1600 w. St Ry Jour—July 1, 1905. No. 70578 C.

Point Shifter.

A New Automatic Point Shifter. J. P. Tierney. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Illustrated description of the point shifter used on the Dublin United Tramways system. 2500 w. Elec Engr, Lond—June 2, 1905. No. 70190 A.

Power.

Power Generating and Distributing System of the Old Colony Street Railway. Illustrated detailed description of the Quincy Point power house and its equipment, and the power scheme of an extensive system. 3000 w. St Ry Jour—June 10, 1905. No. 70139 C.

Publicity.

Publicity. J. Harvey White. Read before the St. Ry. Assn. of the State of N. Y. Discusses the attitude of the press toward public service corporations, and describes the work of the press agent of the Boston Elevated Company. 2300 w. St Ry Jour—July 1, 1905. No. 70577 C.

Repairs.

Repairs to Equipment. M. M. Nash. Read before the Indiana Elec. Ry. Assn. Suggestions for securing the best results in the maintenance of the equipment. 3300 w. St Ry Rev—June 15, 1905. No. 70289 C.

Shops.

Improvements in Metropolitan Elevated Shops, Chicago. An illustrated article giving information concerning the improvements introduced. 2000 w. St Ry Jour—July 1, 1905. No. 70573 C.

Single Phase.

The Single-Phase Railway System in Italy. E. A. Kerbaker. Describes the Roma-Civita Castellana line now under construction. 2000 w. Elec Rev, Lond—June 2, 1905. No. 70192 A.

Subway Drainage.

Drainage of the Interborough Subway Under the Harlem River. Brief illustrated description of the drainage and pumping system adopted, and the precautions taken to meet possible conditions. 700 w. Ir Trd Rev—June 22, 1905. No. 70355.

Subway Ventilation.

New York Subway Ventilation. Konrad Meier. A discussion of the present condition, showing that the exchange of air is too slow, and the ventilation inadequate. 2000 w. Eng Rec—June 17, 1905. No. 70292.

The Cause of High Temperatures in the New York Subway. Editorial discussion of the amount of heat developed. 1500 w. Eng News—June 15, 1905. No. 70238.

The Problem of Ventilating the New York Subway and Similar Tunnels. Editorial discussion of the heat losses by conduction through the walls of the subway, and remarks on ventilation. 2500 w. Eng News—June 22, 1905. No. 70348.

Three-Phase.

Three-Phase Traction. F. N. Waterman. Deals particularly with specific features of three-phase traction, and with some of the results attained and to be expected in practice. 10300 w. Am Inst of Elec Engrs—June, 1905. No. 70251 D.

Toronto.

Niagara Power at Toronto. Facts as to the railway and lighting situation, which are to receive power from Niagara, 75 miles distant. 2500 w. Elec Wld & Engr—June 24, 1905. No. 70386.

Trolley.

Design of a Pantagraph Trolley. C. P. Nachod. Illustrates and describes the design and gives an investigation of the mechanism. 800 w. Elec Wld & Engr—June 10, 1905. No. 70157.

Valtellina.

Investigations of the Performance of Polyphase Traction on the Valtellina Railway (Versuchsergebnisse über Stromverbrauch und Rückgewinn auf der Valtellinabahn und einige Eigenheiten der Drehstromtraktion). Eugen Cserháti. A detailed examination of the efficiency of polyphase traction with the new locomotives on the Valtellina railway. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—June 9, 1905. No. 70446 D.

The Valtellina Railway. E. Cserháti. A summary of experience and results of tests of the working efficiency and other important features of three-phase railway working. 3500 w. Tram & Ry Wld—June 8, 1905. No. 70397 B.

Wheels.

The Steel Wheel for Street Railway service. George L. Fowler. States the probable advantages of using a steel wheel, and briefly discusses type, material, &c. 2400 w. St Ry Jour—June 17, 1905. No. 70271 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Societe d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

Note—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* The Engineering Magazine.

Automobiles.

The Automobile Pocketbook. A Compendium of the Gasoline Automobile. By E. W. Roberts. Size 3½ in. by 5 in.; pp. viii, 329. Price, $1.50. Cincinnati: The Gas Engine Publishing Co.

The author of this convenient little handbook is well known as a specialist upon the subject of internal-combustion engines, and he has brought his experience to a most practical service in the preparation of the present volume. After a brief description of the working of four-cycle and two-cycle motors, the author passes at once to the discussion of gasoline as a fuel, including carburetting and ignition, followed by chapters devoted to description of mechanical details and the operation of the different parts essential to all gasoline automobiles. Among the most practical portions we may call attention to the chapters on automobile tests, operation, and care of an automobile, and the method of meeting the various emergencies which are apt to occur on the road. The book is in most convenient form for the pocket, and will doubtless find very general acceptance as the companion of the automobilist everywhere.

Electricity.

Cyclopedia of Applied Electricity. A Practical Guide for Electricians, Engineers, Students, Telegraph and Telephone Operators, and all Others Interested in Electricity. Prepared by a Corps of Experts, Electrical Engineers, and Designers. Five Volumes; Size 7 in. by 10 in. Price per volume, $3.75. Chicago: American School of Correspondence at Armour School of Technology.

The development of correspondence methods of instruction has been accompanied by the production of a number of text books especially adapted for the needs of students in the different courses, and also of much value to many others who may be following independent methods of work. Among these text books we find the excellent electrical series issued by the American School of Correspondence, this forming a department of the Armour School of Technology at Chicago, conducted under the full control of that well-known technical instituion.

This series, consisting of five fully illustrated volumes of about four hundred pages each, begins with the elementary principles of electricity, and conducts the student or reader through the practical working methods of electrical measurement to the various details of telegraphy, telephony, electric generators, both continuous and alternating, electric lighting, power, and traction, and the general construction and operation of electric generating stations.

Such a wide field necessarily demands the services of a number of authors, each a specialist in his own line, in order that the whole may be effectively covered, and that such a course has been followed in the preparation of these volumes is evident from a perusal of the list of collaborators. Thus, under the general editorial supervision of Mr. Alfred E. Zapf, the secretary of the American School of Correspondence, we find, as collaborators and authors the names of such specialists as Dr. F. B. Crocker, Professor William Esty, Professor Dugald C. Jackson, Professor George C. Shaad, and a number of others.

The several sections of the books form the instruction papers of the correspondence school, and are accompanied by selected review questions, enabling the independent reader of student to check his own work, while the student in the correspondence school has also the supervising aid and instruction of the school to supplement the books.

For the purpose for which these books are intended it is very necessary that the explanations and descriptions shall be given in the clearest possible manner, and hence the question of the extent to which mathematical methods are to be used becomes important. There are some portions of electrical science which demand the employment of mathematical terms and expressions, but these portions can be made clear to the general reader by the use of carefully written explanations, together with the use of diagrams, and both of these methods have been judiciously employed in the sections requiring them

Gas Engines.

Gas Engine Design. By Charles Edward Lucke. Size 6 in. by 9 in.; pp. viii, 254. Price, $3.00. New York: D. Van Nostrand Company.

The increasing number of books upon the subject of internal-combustion motors is clearly indicative of the growing interest in this important department of mechanical engineering. Many of the existing works are devoted to what Dr. Lucke calls the qualitative or inventive side of design, and hence he has distinctly limited himself to the quantitative side of design, his book treating solely of the forces in, and the energy-transforming power of the standard mechanism of the explosion gas engine. The book is the outgrowth of the author's lectures before classes at Columbia University, and in view of the important original investigations which he has conducted in the mechanical laboratory there, and the practical experience thus developed appears in the character of the work.

The first portion of the book treats of power, efficiency, and economy, giving the material necessary for determining the proper piston displacement for a specified output for a given kind of gas. The second part contains the data and method for determining the stresses in the parts, and the arrangement for the production of the required turning moment and proper balance. The third, and larger part of the work covers the computation of the dimensions of the various parts to resist the stresses, including both theoretical analysis and empirical formulas, the discussion extending from the small, high-speed automobile motor to the 5,000 horse power station engine.

It will thus be seen that Dr. Lucke has given the designing engineer a handbook not unlike certain well-known works treating of steam engine design, and its appearance is to be welcomed, not only on account of the intrinsic excellence of the work itself, but also because it indicates the welcome fact that gas-engine design has taken its place as a recognized department of mechanical engineering both in theory and practice.

Mechanics.

Elements of Mechanics. Forty Lessons for Beginners in Engineering. By Mansfield Merriman. Size 5 in. by 7½ in., pp. 172. Price, $1.00. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

It is a matter for congratulation that the preparation of elementary text books is no longer regarded as beneath the dignity of the eminent engineer or professor, and that books like the above are appearing to enable the beginner to establish a groundwork in accordance with modern methods, a foundation which he shall not have to unlearn as he makes further progress.

Professor Merriman has given in this little work a sufficient presentation of the methods of rational mechanics to enable any student, possessing only a knowledge of plane geometry, elementary algebra, and plane trigonometry, to acquire the fundamental elements of mechanics, and to be ready to advance safely and surely to a higher treatment of the subject when it shall be required. If, as the author says, these forty lessons are thoroughly mastered, a solid substructure will be formed upon which applied mechanics may safely stand, and this is all that many will need, while those who desire to proceed further will be far better equipped if they have taken this course than if they have had a less substantial groundwork.

Piping.

Steam Pipes. Their Design and Construction. By William H. Booth. Size 6 in. by 9 in.; pp. x, 187. Price, 6s., $2.00. London: Archibald Constable & Co., Ltd. New York: The Norman W. Henley Publishing Company.

Mr. Booth has here taken up a subject concerning which there is elsewhere little modern information to be found, and has given it a very systematic and scientific consideration. The older formulas were empirical in their nature and were based upon conditions long since obsolete, so that it was necessary to take up the subject anew and treat it wholly upon its merits, conforming to existing practice and commercial conditions only so far as absolutely necessary.

After discussing the relation of the flow of steam to the dimensions of the conveying pipe, Mr. Booth proceeds to examine the materials employed for different uses, taking into account especially the demands of modern high pressures and superheating temperatures. Especially important are the methods of providing for expansion and contraction strains, together with the stresses which are liable to be caused by improper methods of making connections and defective drainage, these frequently being greater in magnitude and effect than those due to the internal pressure. Questions of general arrangement and erection of pipe systems are discussed, together with details of valves, fittings and flanges, there being also a chapter upon separators, and one upon superheated steam. The book concludes with an examination of the kinetic theory of gases in relation to the flow of steam. Although based mainly upon British practice, the book is of distinct value to engineers in all parts of the world, and it will doubtless fill a place in engineering literature hitherto vacant.

THE
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"THE WORLD IS ITS FIELD"

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THE ACTUAL PROBLEMS OF THE PANAMA CANAL.

By John F. Wallace.

PRELUDE.

As opportunity offers, the writer desires, through the medium of THE ENGINEERING MAGAZINE, to contribute a few notes from time to time on the Panama Canal, touching briefly on its history, various plans suggested for its construction, the organization and methods, and also the general features of the work. Consideration will be given to the various factors entering into the problems of administration and control, as well as to the consideration of the engineering and technical features of plan and construction.

In the consideration of the subject as a whole these various features are as essential to a comprehensive consideration of the subject as the warp and woof of a woven garment to its integrity.

INTRODUCTION.

WHEN Balboa, after being tossed for weeks and days on the troubled waters of the Caribbean Sea, landed on the Isthmian shore, fought his way through a tropical jungle to the backbone of the continental divide, and, gazing southward, perceived the comparatively calm waters of the Pacific Ocean in Panama Bay, he little dreamed of the many troubles contained in the Isthmian addition to Pandora's box, which would escape by the after suggestion of the possibilities of construction of an Isthmian canal. Men have come, and men have gone; lives, reputations, and fortunes have been sacrificed at the altar of this idol. It is to be hoped that we are now standing at last on the threshold of a consummation.

The momentum of the idea, which has lived through several centuries, and which has now been adopted and absorbed by America's largest nation, is a strong guarantee that at some time, in some way, and at some cost, the original idea will finally be realized, although the price which is yet to be paid in lives, reputations and money, and the time required to do the work are as yet undetermined quantities.

The writer desires, through the pages of this magazine, to give the engineering profession, and the country at large, such information as he thinks will, in some measure be useful in assisting those interested to arrive at a more accurate understanding of the subject. It will be his endeavor to consider the subject from the standpoint of a disinterested and unprejudiced investigator, without fear or favor of those who may be selfishly interested politically, financially, or otherwise, eliminating all motives of malice or self interest. Although it is not to be expected that his views will meet the approval of all, he at least desires that his loyalty to his country and the sincerity of his motives will be appreciated.

HISTORY.

COMMENTS ON THE FRENCH PHASE.

While it is not desirable to go into the full details of the pathetic history of the De Lesseps project, it contains many lessons, which, even at this time, deserve careful consideration in order that the pitfalls of the past may be avoided. Frequently the greatest successes are based on gigantic failures, and the success of the few is generally achieved by a careful study and analysis of the causes that have led to the failure of the many.

No one will question either the purity nor the grandeur of De Lesseps' original conception of a sea-level canal at Panama. His failure was not due to the impracticability of his conception, or to the impossibility of its execution, even with the means at his command under ordinary conditions. His failure was brought about by the selfishness and insincerity which animated his advisers and followers, assisted by financial complications, and accelerated by climatic conditions. To what extent the American project will be hampered in this way remains yet to be seen. It will certainly be the part of wisdom to refrain from undue criticism of the past until the tale of the future is told.

The Technical Studies of the French were apparently exhaustive, and are entitled to most careful consideration by American engineers in charge of the work. Such studies supplemented by careful investigation and verification, particularly as to basic facts, will be of material assistance in arriving at proper conclusions. The elaborate preparations made by the French, and the provision for the health and comfort of employees were certainly creditable, and in the light of sanitary knowledge available at that time, were excellent. Considering all the conditions, the amount of work actually accomplished was substantial at least, and from an engineering point of view success would have been obtained, had the moral, commercial, financial and climatic influences been less potent.

COMMENTS ON THE AMERICAN PHASE.

For the last fifty years consideration has been given to the project of an Isthmian canal by the American people. Every possible route has been investigated in a more or less imperfect way, from the tunnel project of the San Blas Route at Darien to the Ship-Railway Scheme of Captain Eads at Tehuantepec, and volumes have been written containing a mass of information and misinformation by engineers and others, some of whom have made careful examination of the various routes, and some who have never seen the Isthmus or been affected by the debilitating influences of a tropical climate; and, as usual in a consideration of important subjects, those who have known the least have been the most positive in their convictions and in the expression of their opinions, it being much easier to build theories from one's inner consciousness than to accumulate data, analyze, and deduce conclusions from the accumulation of hard cold facts.

Up to the time of the report of the first Walker Commission the complications surrounding the political and financial conditions of the Panama enterprise seemingly made the consideration of that project by the American people an impossibility; therefore American interests had been turned to other schemes, principally to Nicaragua, which seemed the most practicable. The investigations of the original Walker Commission, composed of the flower of the engineering profession of America, were confined to a consideration of the comparative merits of the various general routes proposed, and had nought to do with the detailed features of any route, beyond what was necessary to arrive at the best general proposition.

Careful consideration by this Commission resulted in the selection of the Nicaragua and Panama routes as most practicable ones. As the central feature of the Nicaragua route comprised an artificial navigable lake ninety to one hundred feet above the sea, with a flight of three locks on either side of a continental divide, approached by sea-level sections from either end, it was obvious that, in fairness for comparative purposes, a similar plan should be considered at Panama, embracing an artificial lake for the summit level at approximately the same elevation, the two schemes being thus on a similar basis.

Principally for this reason, although not so stated, it is evident that the original Walker Commission did not feel called upon to consider a sea-level project at Panama in full detail, as the physical conditions at Nicaragua render a lock canal with a summit level of approximately ninety feet imperative for that route. Consequently, the Commission, more or less wisely forebore injecting an uncertain and disturbing element into the situation by doing more than casually mentioning the possibilities of a sea-level canal at Panama at an expenditure of time and money practically double the amount estimated for the completion of either the Nicaragua or high-level Panama projects.

Using the same unit prices in its comparative estimates, the Commission found that, as a matter of physical construction, the Panama route was approximately forty-five million dollars the cheaper, considering original cost alone. While a more thorough investigation of the physical conditions at Panama might have caused the Commission to increase its estimate for that project, it naturally relied upon what seemed to be the thorough borings and investigations made by the French, supplemented by examinations of its own, considering that American engineering ingenuity and management would overcome any material increase in cost due to unforeseen difficulties, particularly as an allowance of twenty per cent to cover administration, sanitation, engineering and contingencies was included in the estimate.

At that time the uncertain financial feature was the amount for which the franchise and property of the French Company could be secured. As this amount had been fixed by the French Company at one hundred million dollars it induced the American Commission to primarily recommend the adoption of the Nicaraguan route. The common sense and Yankee shrewdness with which Admiral Walker and his colleagues handled the negotiations resulted in the French Company modifying its price to some forty million dollars, which indicated the probability of the Panama route being the most economical. This resulted in the Walker Commission reconsidering its first recommendation, and suggesting the advisability of selecting the Panama route, which was provisionally adopted by the American Congress through the passage of what is known as the Spooner Bill, appropriating the necessary money therefor, and authorizing the President to construct an Isthmian canal on either the Nicaragua or Panama route, depending on his ability to bring to a successful conclusion the negotiations with the French Company, and the consummation of a suitable treaty with the Republic of Colombia.

Admiral Walker, under the direction of the President brought the purchase of the property to a successful conclusion. This arrangement appeared to have in it the elements of justness and fairness. While the amount seemed low to the French Company it was practically its last chance to in any way recuperate itself for the large amount of money more or less wastefully expended. At the same time the American Government secured the franchise, a certain amount of physical property, and the accomplishment of some work, besides the results of years of valuable experience—in all a consideration for which it would doubtless have required an expenditure of a large amount of money, particularly had it undertaken the construction of the Panama Canal *de novo.*

Later the manipulations and finesse of the confidential agent of the Panama Canal Company brought about the birth of the infant Republic of Panama, which made it possible for the American administration to cut the gordian knot of diplomacy, and consummate the transaction, thus ending the first phase of American control of the Panama project. This latter event happened during the close of the year 1903.

The story of how a syndicate was formed to buy the control of the French Company, educated the American people to look with favor on the Panama route, and created a new national entity with which the United States could negotiate a treaty. The making of the Panama Canal even a possibility is yet to be told by those men more familiar with the history of these transactions than the writer.

THE SECOND PHASE.

In the early part of the year 1904 the Commission authorized by the Spooner Act was created by the President, with Admiral Walker at its head, and consisted of Professor W. H. Burr, a member of the old Commission, General Geo. W. Davis, B. M. Harrod, Wm. Barclay Parsons, C. E. Grunsky, and Frank J. Hecker. This Commission organized, and during April, 1904 proceeded to the Isthmus to make a preliminary investigation. General Geo. W. Davis, one of the Commission, was appointed Governor of the Canal Zone, and placed in temporary charge of the work until the appointment of a Chief Engineer. Four parties of engineers were organized, and sent to the Isthmus to begin technical investigations; one, under Mr. List, with instructions to investigate all matters relating to the harbor of Colon, and the Caribbean Sea section; a second, under Mr. Nichols, to investigate the possibilities of a dam site at Gatun; a third, under Mr. Dose, to make detailed investigations and studies of the Bohio Dam site, and what is known as the Tiger Hill Cut-Off; the fourth, Mr. Ehle, to investigate the dam sites at Gamboa and Alhajuela, and the various questions relating to the watershed of the Chagres, with instructions to consider in detail possibilities of various spillways necessary should either the Gamboa or the Alhajuela Dam be determined on, and, incidentally, tunnel spillways either to the Pacific or Caribbean slope.

In the mean time Major Black of the U. S. Engineer Corps was placed temporarily in charge of the engineering work, and assisted by Lieut. Brooke, and Mr. Harper, Resident Engineer, was instructed to take over the French construction work, which was at that time actually in progress in a small way in the vicinity of Culebra, the summit excavation.

For approximately a year previous Major Black, assisted by Lieut. Brooke and Mr. Harper, had been stationed on the Isthmus observing the French methods, and making a general study of the work. On May 4, 1904, Lieut. Brooke, under direction of Major Black and General Davis, took over the work in accordance with instructions from Mr. Russell representing the State Department.

The writer was appointed Chief Engineer of the Isthmian Canal Commission effected June 1st, 1904. After conference with the Commission at Washington, he proceeded to the Isthmus, arriving there on June 28th. While the "Spooner Act" seemed to determine in a general way that the Canal should be constructed in accordance with the plans outlined in the Report of the original Walker Commission, providing for a lock canal with a summit level some ninety feet above sea level, including the proposed artificial Lake Bohio; the Commission desired the Chief Engineer to investigate all features of the problem, in order that the best possible plan might finally be selected.

It was understood, however, that changes in detail even to the extent of eliminating the artificial Lake Bohio, or selecting other sites for the locks and dams than those outlined in the Walker Report would be admissible under the Spooner Act, provided such changes did not increase the cost of the work over the $144,000,000 Estimated Cost as set forth in the Walker Report and provided for by the Spooner Act.

The work under the Chief Engineer was divided under two general heads.

1st. *The Technical Studies*—(a) To determine the practicability of the plans and alternate details of plans recommended for consideration by the first Walker Commission.

(b) To determine by examination, study and verification of the French data supplemented by original investigation of all possible factors affecting the problem, to the end that no question might in future be raised as to the wisdom of the adoption of whatever plan might be finally selected.

2nd. *Construction*—Under normal conditions construction work should only follow the most complete and thorough study of all the elements of the scheme under consideration. Considering the magnitude of the problem the Panama Canal has been remarkable in the vast amount of inaccurate or partial information which has heretofore preceded the expenditures of such large sums of money as will be necessary to successfully accomplish the desired result.

When the United States came into possession of the Panama Canal, construction work was being carried forward at the "Culebra Cut," the summit excavation, at the rate of about one thousand cubic yards per day, approximating some 25,000 cubic yards per month, costing sixty-five cents per yard according to the claim of the French Co.; but, estimating on the basis of Mayor Black's report of yardage removed under his observations, the cost averaged nearly eighty cents per yard. The material being removed consisted of all the various classes constituting the Culebra soft yellow clay, underlying which was hard basaltic rock under the main divide, flanked to the northward by soft rock, shales and clays.

The work was largely hand labor, the use of machinery having gradually been discarded on account of its worn out condition. The organization under the direction of the French Director of Works consisted of such a staff in field and office as was needed to supervise the working force at Culebra which consisted of about five hundred men, superintendents, foremen, clerks, and laborers—mostly Jamaica negroes, but with some French, Spanish and Americans filling the higher positions. The labor, skilled and unskilled, was paid at about one-third the rates at present prevailing in the United States, the common laborer receiving about fifty cents per day in the U. S. Currency equivalent. The lower rate of wages paid should be remembered in considering the cost of work later for comparative purposes. It was considered desirable to utilize the French working organization as the nucleus, to be enlarged and expanded as the work progressed. Cost of, and time required for the completion of the Summit excavation at Culebra is the controlling factor of the problem, while the amount of material required to be removed will very from 50,000,000 to 250,000,000 cubic yards, more or less, according to both general and detail plans hereafter to be adopted. At least about 50,000,000 cubic yards will require removal even to provide a canal on the ninety foot above the sea level plan. It will therefore be apparent that, subject to certain conditions, the construction work could be carried forward pending the consideration of the final plan. Again, as time and cost are largely controlling elements which should be known in the consideration of all plans, it is evident that the data attained from actual work would form a valuable basis for such consideration. The work was therefore carried forward with this end in view.

During the year ending June 30, 1905, the technical studies, surveys and construction work have been organized and carried forward as indicated. A general engineering and construction organization has been built up to control; supervise, and carry on the work. The general administration of the work was under the direction of the Chief Engineer assisted by the officers under him. The routine work was supervised by a series of bureaus, the heads of which reported to, and received their instructions from, the Chief Engineer.

BUREAU OF SUPPLIES.

This bureau has the control, custody and issue of all supplies, materials and machinery in store, supervising requisitions and keeping record of the same, and also purchasing such supplies as are needed immediately and can be procured locally.

BUREAU OF PERSONNEL AND QUARTERS.

Controls all matters relating to applications for employment on the Isthmus, *i. e.*, records of employees, supervision of time-keeping; housing and quartering of employees; providing transportation and, in fact, exercising general control and care over all employees as to their records of service, personal comfort and necessities.

BUREAU OF BUILDING AND ARCHITECTURE.

Planning, desigining and constructing all new buildings; supervising the repairs and maintaining buildings in use, this including 2,400 buildings, storehouses, dwellings and other buildings constructed by the French Co.

BUREAU OF MACHINERY.

Contracting the design of new shops and machinery, the construction and repair of the same, thus filling the same functions as a machinery department in an American railway system.

BUREAU OF MAPS, PRINTING AND LITHOGRAPHING.

All work of the above character needed on the Isthmus is performed by this bureau.

BUREAU OF CLIMATIC CONDITIONS AND RIVER HYDRAULICS.

Engaged in the collection and compilation of data on these and all related subjects.

BUREAU OF COMMUNICATION.

Planning, constructing and maintaining telephone and telegraph lines and all methods of communication. The construction work is divided tentatively into five divisions under the control of division engineers to be selected as the necessities of the work demand it, who should have control of all construction and engineering work inside the limits of their respective territorial boundaries. Under the division engineers resident engineers supervise separate or special work; technical or construction. Under the resident engineers assistant engineers are employed with the usual organization of instrument men, rod-men and chain men. The details of the divisional and bureau organizations will furnish material for a separate article, and are only touched upon at this time in order to give the reader a general idea of the conduct of the work.

In selecting the Advisory Board of Engineers to consider the general plans proposed for the Panama Canal, no engineer from Mars, that planet of canals, was included.

An engineer from Mars in considering this problem from a disinterested standpoint unaffected by any motive except to obtain full information of the basic facts and arrive at a correct conclusion would want to know.

1. Why build an Isthmian Canal?

A. General reasons affecting civilization

B. Special reasons affecting United States.

C. Political policy questions to be considered.

D. Commercial policy and reasons as to its necessity.

C. Patriotic reasons therefor.

2. If the construction of an Isthmian Canal is necessary or advisable, have all other routes been fully and properly considered and has it been fully determined that the Panama is the most practicable and best, and why?

3. As the function of a canal is simply the transportation of persons and material across a given space in the shortest time and at a minimum expense, what consideration has been given to this face of the question comparing a canal with other facilities for accomplishing the same result?

4. In case facts and conclusions show Panama to be the best route and a canal to be the most practicable service for accomplishing the

purpose, what information is at our command to determine the following points in considering the selective merits of different plans?

A. Utility.
B. Cost of construction.
C. Time required for completion.
D. Cost of maintenance.
E. Cost of operation.
F. Time of transit.

While comparative advantages and difficulties should, if possible, be measured by financial and commercial considerations, questions of general policy should be considered and the element of human judgment cannot be entirely eliminated.

5. Following the selection of a general plan, important details would be taken up and after full consideration, decided upon.

A. Harbor approaches and works including docks, wharfs, anchorage basins and incidental facilities.
B. Cross section of canal, treatment of slopes and other matters.
C. Location and character of locks, dams, spillways.
D. Division channels, care of flood waters from adjacent drainage slopes.
E. Control of Chagres and other rivers and principal works pertaining thereto.
F. Water and sewerage for cities, towns and working settlements.
G. General sanitation and care for treatment of ill and injured employees, hospitals, etc.
H. Provisions for working force, quarters, commissary, amusements, etc.
I. Government of town.

In the execution of the work, however, the last should be considered first.

6. Plans having been determined upon, questions of control, administration, and execution should be considered.

A. Can the work be carried on to the best advantage using the present Governmental Department and Bureau, their methods and machinery?
B. Or should the work be considered of an emergency nature and suitable special provision be made for its proper management as may be required by the unusual conditions existing in connection with it.

7. As to the conduct of the work.

A. Should it be turned over to a general contractor or syndicate.

B. Divided into as many small separate contracts as possible under governmental control.

C. Carried on under immediate governmental direction by hired labor.

D. Or a combination of the last two methods.

What are the advantages for or against these several suggestions?

While the visitor from Mars might be told to confine himself to the question of which of the several plans suggested for the Panama Canal was the best, he would doubtless reply that having come so great a distance and coming from a planet of canal builders he would at least suggest the advisability of the earth's inhabitants permitting him to go into the subject "de novo"—and receiving the full benefit of his experience and knowledge. It certainly would do no harm as the wisdom of the American Congress would be required to formulate the laws needed to make his suggestions effective.

However, the gentleman from Mars would doubtless desire much other information, both general and detail, before passing on the wisdom of the policy to be adopted in planning and executing this important work, having no political ambition (miscalled patriotism), no supplies or machinery to sell, no friends or relatives to provide for, no axe to grind. Never having heard of the modern expression "graft" and having no personal selfish ends to serve, he would naturally desire to know and carefully weigh all facts and form a conclusion that would not only be of the most benefit to mankind, but would also meet the approval of his fellow canal experts upon his return to his native planet.

The highest patriotism will certainly be conserved by considering the question along the lines mentioned above as far as possible. And such will be our effort.

The difficulties met with in building up an organization of 7,500 men consisting of the variety of qualifications needed for the work in a tropical country two-thousand miles from the seat of government, subject to the peculiar conditions surrounding and controlling the Panama Canal cannot be described in a short introductory article. If this and succeeding articles written by the writer or others may assist the reader to a more complete understanding of the Panama problem, the object of the writer will have been accomplished.

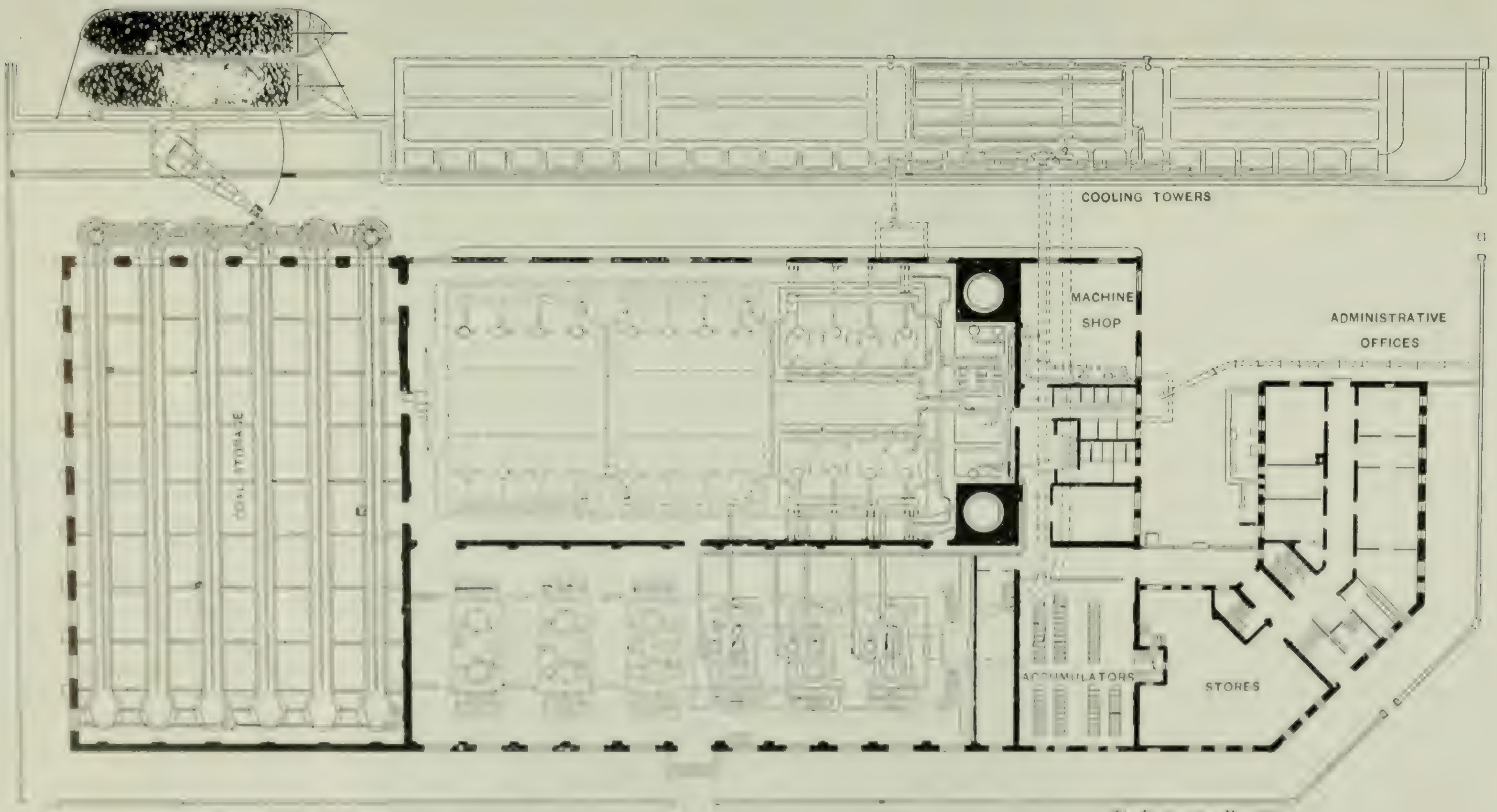
MODERN POWER-PLANT DESIGN AND ECONOMICS.

By Franz Koester.

In introducing Mr. Koester's first article, which appeared in the issue of this magazine for August, we drew attention to the interest and value given to his discussion by the comparisons he makes between Continental, British, and American practice, and the practical information he supplies regarding some of the most important work of the best modern designers. In the following article he takes up coal-handling machinery and the steam-generating plant. A succeeding part of the discussion will take up steam-piping, prime movers, and the condensing plant and auxiliaries.—THE EDITORS.

II. COAL AND ASH HANDLING.

IN modern power plants, the coal and ash handling are carried on either by electrical or mechanical methods, or both. Whether the coal is transported to the plant by water or by rail, it is lifted and hoisted by means of automatic grab buckets, or dumped from the cars directly into the bunkers. In both cases the coal may be crushed if necessary, weighed, and then by means of belt or bucket conveyors, carried to the storage room at the side of the boiler room, or to bunkers above the boilers, usually occupying the space directly beneath the roof. Here the coal may be stored in different bunkers or bins, according to its calorific value, by means of distribution trippers or other devices. Other systems are those employed at the Vienna and Hamburg plants. In the former case the loaded car, with a capacity of 15 or 20 tons, is raised to a track above the bins by means of an electric motor and then dumped into the ten compartments, with a total capacity of 4,000 tons, sufficient for about six weeks normal operation. About the same amount of coal is stored in the "Barmbeck" plant in Hamburg, where the coal is hoisted from barges in hanging buckets by means of a traveling crane and then placed on one of the six closed-loop tracks shown in Figure 20, where the buckets travel by gravity, being automatically dumped at the proper point, and then return to the starting point and are again lowered to the barge. The cut represents the plant as at first installed in 1900. This comparatively large storage capacity is necessitated on the continent of Europe on account of the frequency of strikes, which however are usually of short duration.



The Engineering Magazine

FIG. 20. PLAN OF THE BARMBECK PLANT, HAMBURG.

The evaporation of water with a given heating surface varies with the calorific value of the coal. A coal rich in carbon naturally produces a greater evaporation than a poor one, and as the theoretical heat units per pound of coal varies say from 9,000 to 16,000 British thermal units, it would be unfair to demand from a stoker, either mechanical or human, the same steam production with both qualities of coal. It is of the greatest importance for the economical management of the plant to keep accurate and complete records of the calorific value of the coal fired by each individual stoker. Tests may be obtained by chemical analysis, by combustion in a coal calorimeter, or by actual test in a steam boiler; the results of the latter, however, are extremely variable.

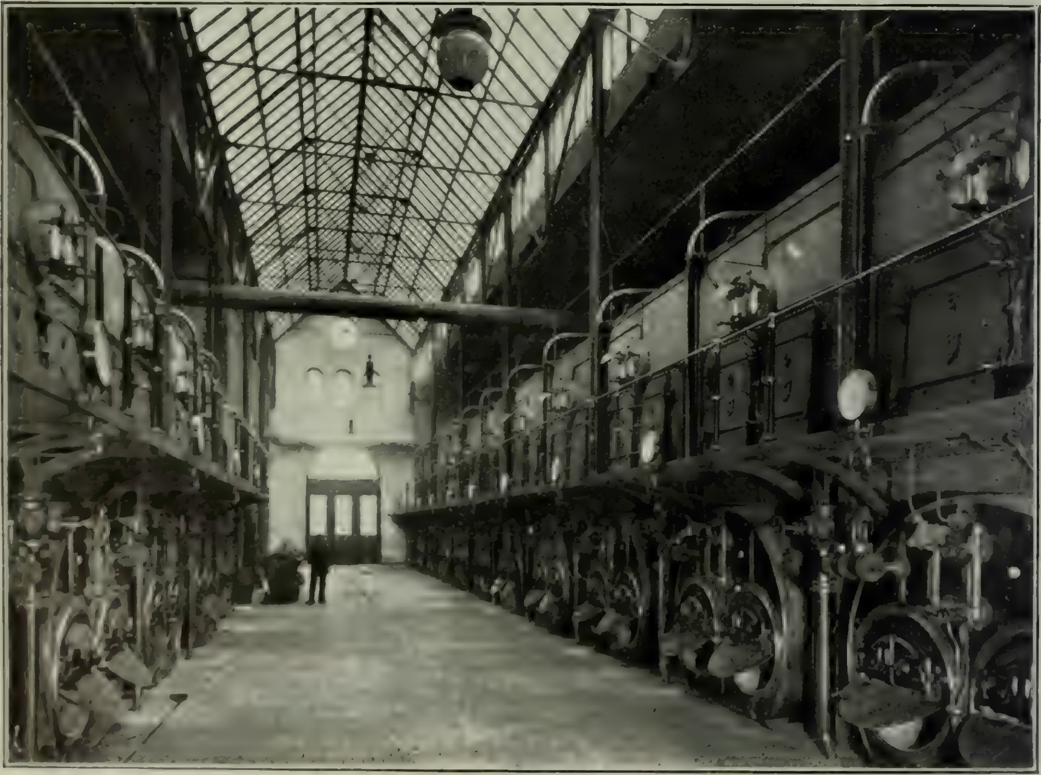


FIG. 21. BOILER INSTALLATION IN THE BILLE PLANT, HAMBURG.

Coal on the continent of Europe is comparatively expensive, hence one will not be surprised frequently to see small cars, after being carefully weighed, hauled before the furnace and coal fired directly from them (see Figures 21 and 22). In the Vienna twin plants, 1.32 pounds per indicated-horse-power hour were consumed, the coal being hand-fired, showing under test 11,940 British thermal units per pound, which means that one indicated horse power was produced by 15,750 British thermal units. The efficiency of the boiler is 72 per cent. These were test figures, and not the average of regular performance.

It will be seen that such favorable results are obtainable only by the employment of skilled stokers and scientific management. Complete tests on the coal and ashes are invaluable to the management.

In connection with their central-station service the New York Edison Co. have recently installed a large coal-storage plant to be used for their various power plants in New York in case of emergency. Owing to the lack of available space at the different stations, this plant has been located on the East River opposite 110th Street in Shadyside; the capacity of this storage plant will be 150,000 tons, two-thirds of which will be for anthracite while the remainder will be for bituminous coal. The entire coal-handling apparatus is being installed by the Dodge Coal Storage Company, and a splendid view is given in the accompanying illustration Figure 23. One of the coal-handling plants connected with their power stations is shown in Fig. 41. In the Moabit plant of Berlin the River Spree was deflected in order to secure a sufficient coal-storage capacity.

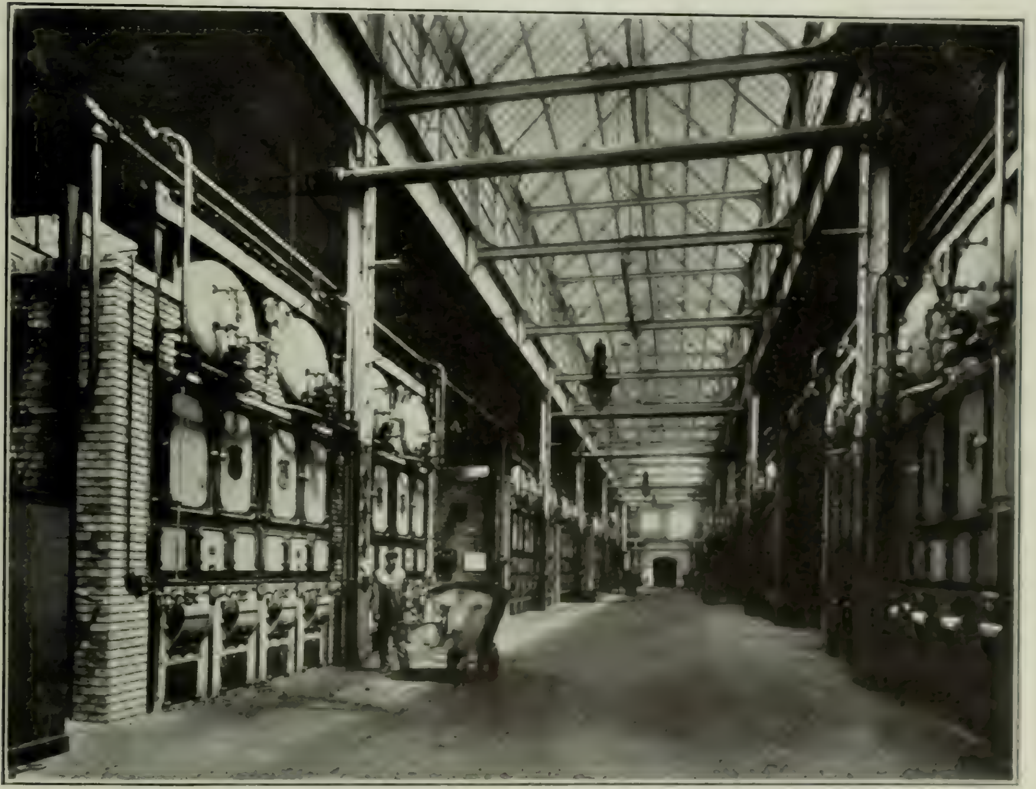


FIG. 22. BOILER PLANT OF THE MUNICIPAL POWER STATION, VIENNA

III. BOILERS.

The judges at the Centennial Exposition in 1876 adopted a standard boiler horse power, which is the evaporation of 30 pounds of water from a temperature of 100 degrees F. to dry saturated steam at

70-pounds pressure, this being subsequently incorporated in the standard code of the American Society of Mechanical Engineers. The expression is still in general use in conjunction with the heating surface. The expression of boiler horse power is unknown on the continent of Europe. At the present time, when prime movers are operating under a pressure of 175 to 200 pounds and more, and feed water is generally calculated at about 200 degrees F, it will be seen that the above expression cannot be of great value. In order to determine the size of steam boiler proportioned for the prime mover, one must consider the design of the boiler, the proportion of grate surface to heating surface, the character of the fuel, and the draft of chimney, or forced or induced draft if such be employed. With a well designed and properly set boiler, the temperature of the waste gases should not exceed that required for a sufficient draft; therefore in an up-to-date plant, to the above mentioned items must also be added the economiser, and—most important of modern power-plant equipments—the superheater.

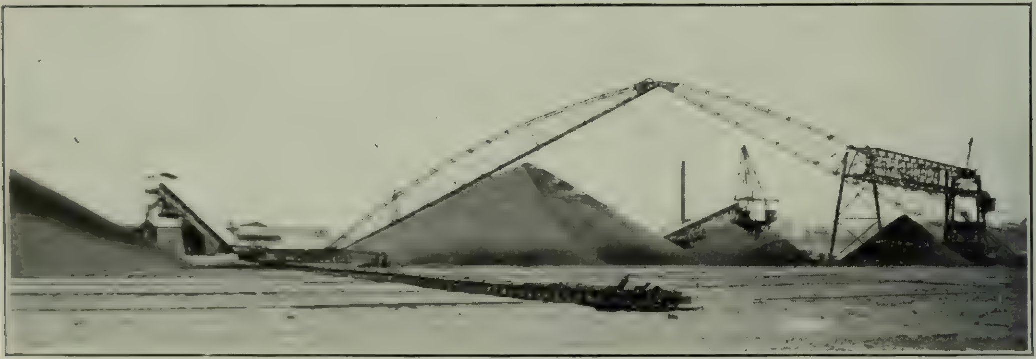


FIG. 23. DODGE COAL STORAGE SYSTEM.
Installed for N. Y. Edison Co. at Shady Side, N. J., by the Dodge Storage Company, N. Y.

Today, with the installation of a high grade of engines and turbines, and the necessary ability to start the individual units at short notice (on account of the sudden fluctuations in load, especially noticeable in railway work) it is necessary to install boilers of equal efficiency. Good power-plant design demands the production of a horse power with the smallest amount of space, without undue crowding in either the engine or the boiler rooms, an example of this already having been shown of 7.5 sq. ft. heating surface per square foot boiler room floor space as against 4.0 in two of the plants recently constructed in New York and Paris respectively.

With the adoption of gauge pressures ranging from 175 to 200 pounds, and even higher, as standard practice in modern plants, the water-tube boiler is without question the safest and most favorable type of steam generator. This has resulted in the production of a great many different types of this kind of boiler, especially on the Continent of Europe, descriptions of which are here impossible. Suffice it to say that the power-plant designer must take into consideration all points which would lead to an efficient and economical operation of the plant, of which the above mentioned items are the most important.

The boilers of the Sheffield plant England, are of the Stirling five-drum water-tube type, manufactured by the English Company. Each boiler has a heating surface of 6,210 square feet, and is provided with four furnaces and a grate surface of 72 Stirling superheater square feet, and a raising the temperature of steam under a pressure of 200 pounds to about 475 degrees F. Each boiler has its own induced-draft system, operated by electric motors, the air supply to the furnace being heated up to 315 degrees F. by the flue gases. Tests reported by Felden in "Engineering" give an evaporation from and at 212 degrees F. or 10.4 pounds of water per pound of coal, the latter having a calorific value of 11,886 British Thermal units. The boiler pressure was 196.8 pounds and the total average temperature of the steam 475.4 degrees F. The efficiency reported to have been obtained, including superheat, is 84.9 per cent while the guarantee

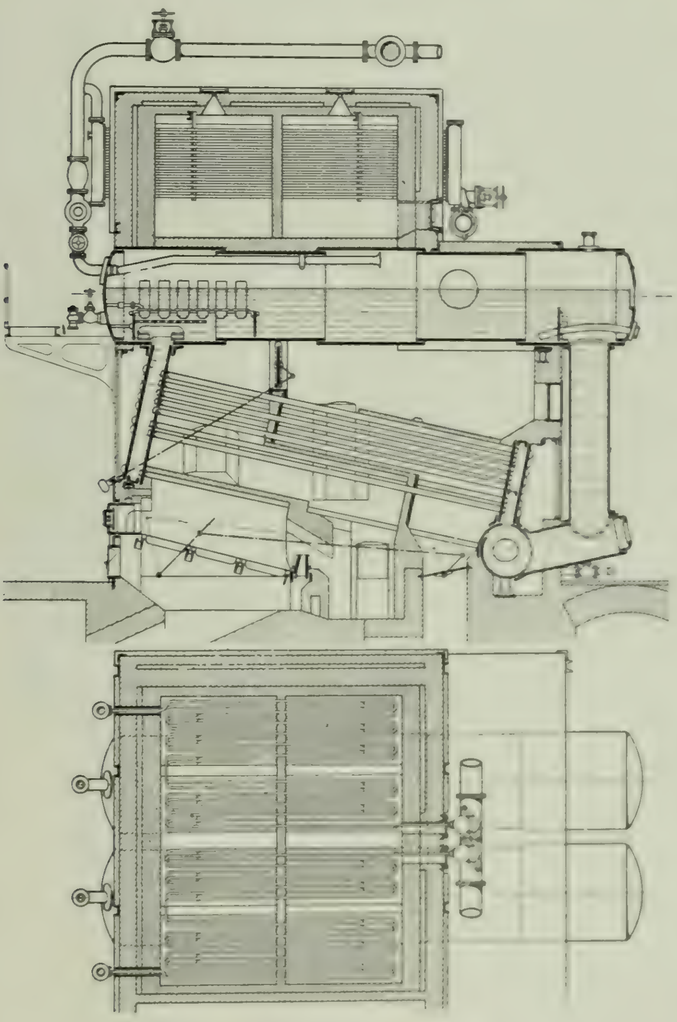


FIG. 24. LEINHAAS BOILER WITH HERING SUPERHEATER

at the most economical load was that it should be not less than 80 per cent.

As it was until recently unusual to have marine tube boilers in a central station, and as two of the recent plants, viz. Carville plant in Newcastle and the St. Denis, Paris, are respectively equipped and being equipped with this type of steam generator, it may be of interest to give here a few details. The boiler of the St. Denis plant is of the

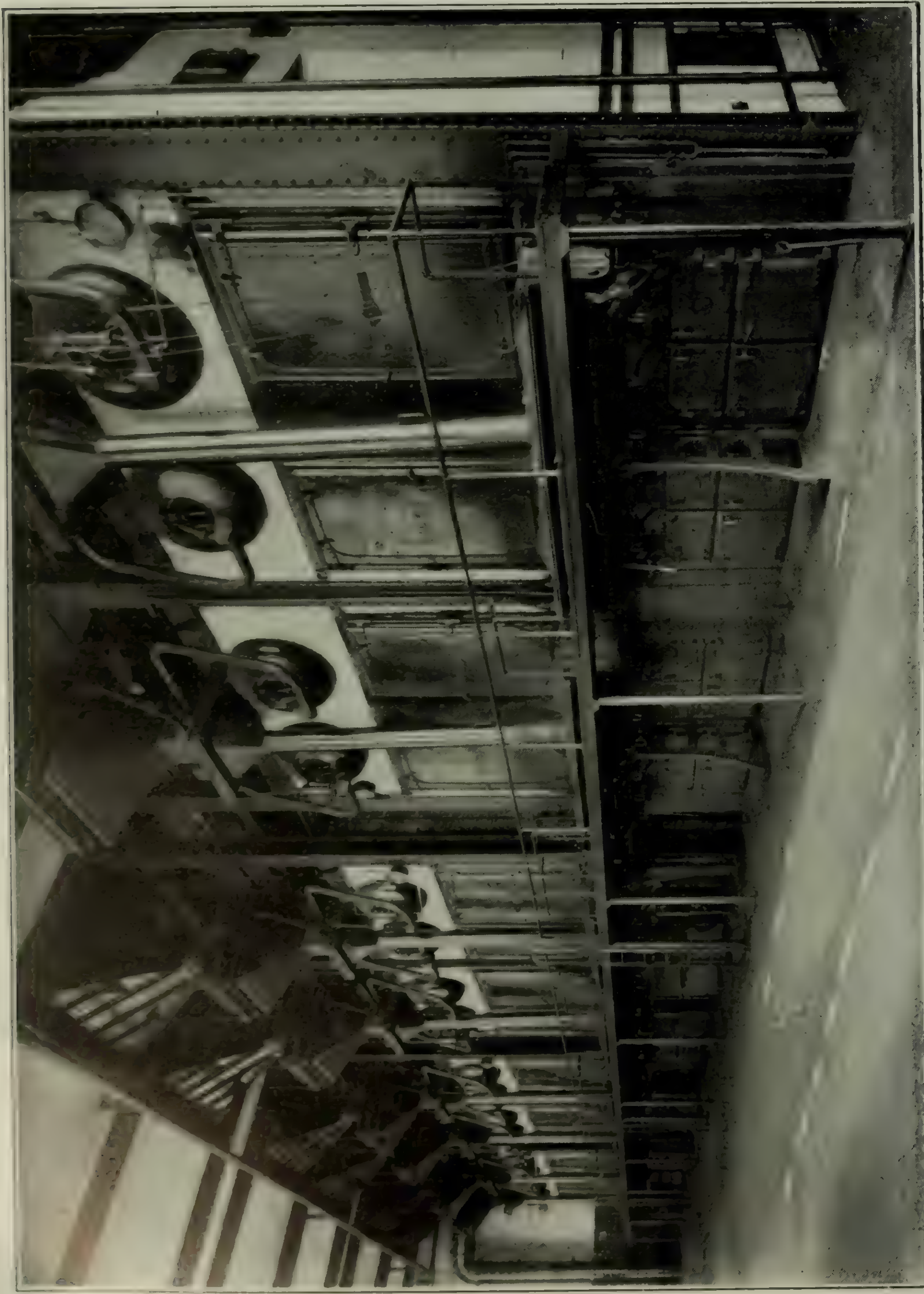


FIG. 25. GROUP OF 8 512 H. P. BABCOCK & WILCOX BOILERS, SUPPLYING STEAM TO ONE 5,000 K. W. CURTIS TURBINE. Installed by The Babcock & Wilcox Co., New York, in power house of The Edison Elec. Ill. Co., Boston, Mass.,U. S. A.

Babcock and Wilcox make, and has a heating surface of 4,494 square feet and covers a floor space of 267.5 square feet. Each boiler has two chain grates of 35 square feet each, and a superheater, of 642 square feet heating surface, made up of seamless drawn bends with arrangement for flooding. The specification calls for a steam temperature of more than 680 degrees F. at a pressure of 175 pounds. The boiler itself consists of a drum about 17 feet long and 52¾ inches in diameter, which lies across the front of the boiler setting, 16.1 feet above the floor level. There are 33 sections of 14 rows water tubes of 3¼ inches diameter, 10.1 feet long, sloped at a large angle. The superheater is located above these tubes. Directly above this boiler unit, 23 feet above the boiler-room floor and close under the roof, is a tier of Green economisers. The whole––boilers and economisers––are supported by steel construction, in a very compact way in order to reduce the loss of heat to a minimum. Between the economisers and the middle of the boiler house is a steel constructed coal bunker, from which the coal dumps into the stoker hoppers. The ashes are collected in the basement floor (9.8 feet below the boiler floor) and carried away by the same bucket conveyor which takes the coal to the

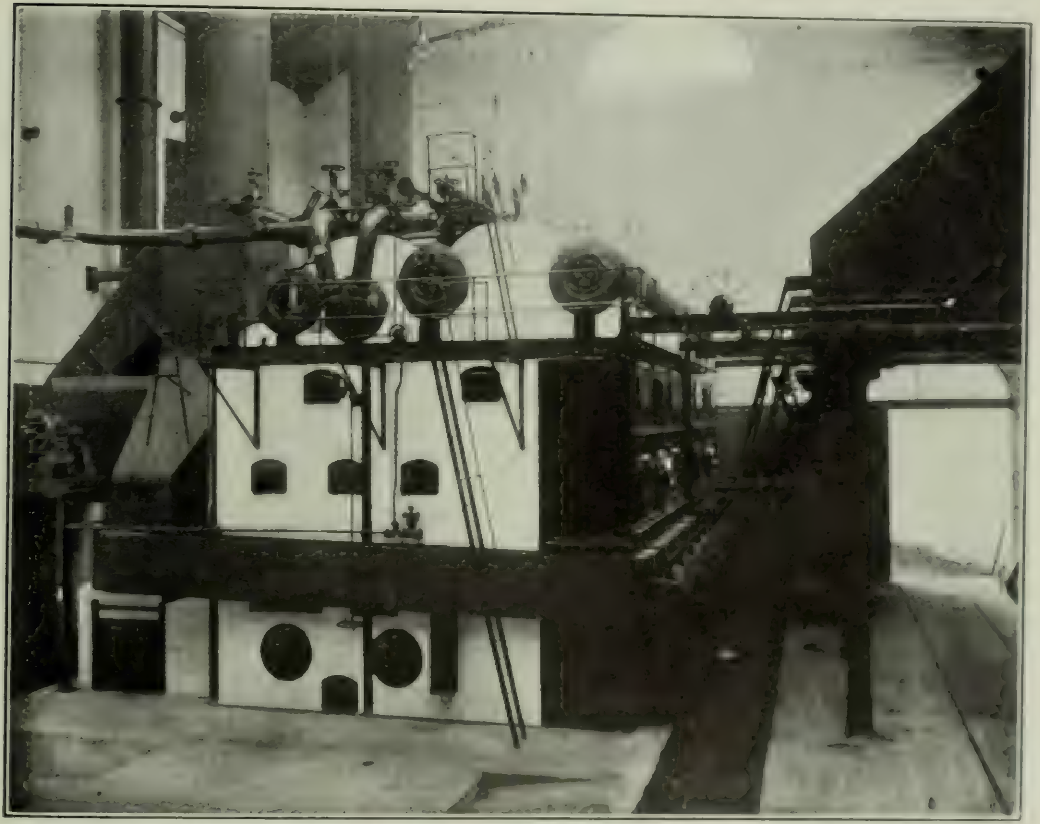


FIG. 26. STIRLING BOILERS AT SHEFFIELD (ENGLAND) ELECTRIC LIGHT STATION.

bunkers. From the basement floor to the top of the boiler house is about 65 feet only. It will therefore be seen that not only the boiler itself is compact, but the entire boiler plant, which may also be said of the turbine house. Compared to this it may be noted that the New York Subway plant, having also one basement floor, one boiler floor, one economiser floor, as well as a coal bunker, has a height from basement floor to the top of the boiler house of 125 feet.

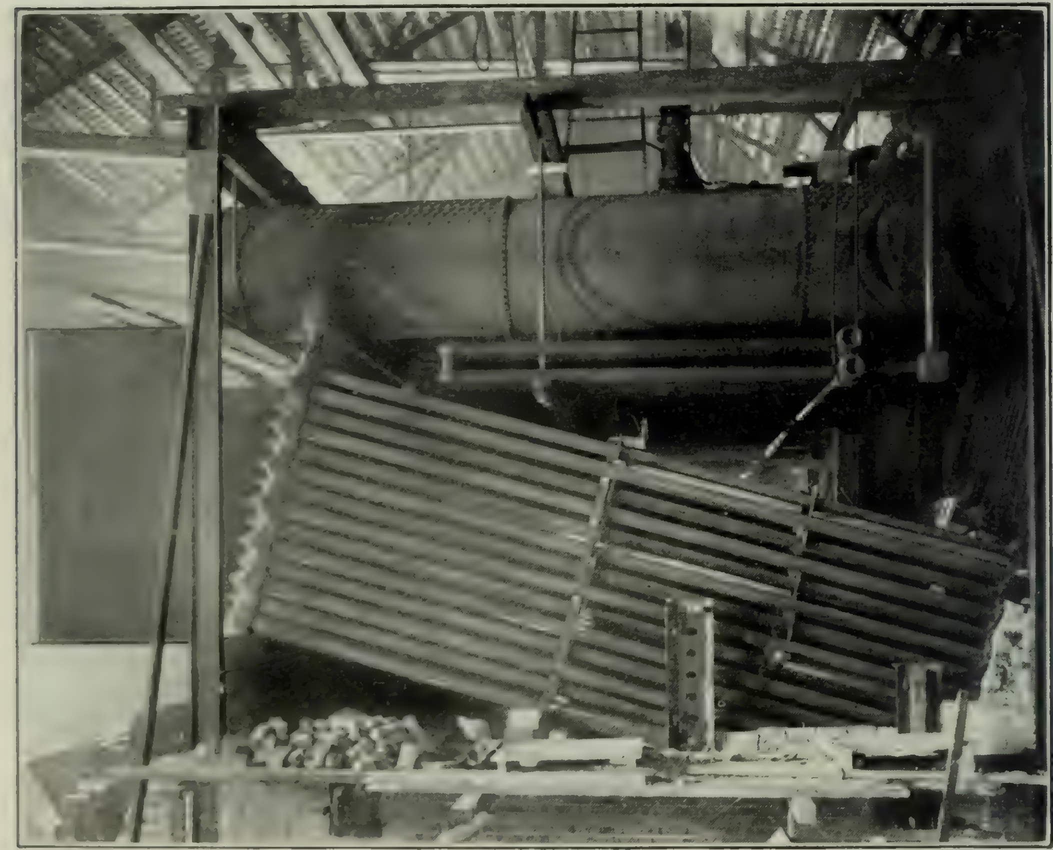


FIG. 27. PART OF THE BOILER PLANT, FULLERTON AVENUE POWER STATION, CHICAGO MUNICIPAL LIGHTING PLANT.

Foster superheaters and water-tube boilers; units 520 h. p. each; 165-lb. pressure and 125 degrees superheat. Power Specialty Co., N. Y.

To the convenience of the boiler attendance often too little attention is paid. Galleries in the front of the boilers above the fire doors and a platform on the boiler itself greatly facilitate the operation. The constructor of the New York Subway plant, after visiting continental plants, has successfully used this system.

IV. STOKERS, SMOKE CONSUMER, AND DRAUGHT.

Mechanical underfeed and overfeed stokers are much more commonly used in the United States than elsewhere. This may be due to the high wages required for skilled stokers and the low price of coal, in

America. It is certain that with a mechanical-stoker equipment, regardless of type, a boiler cannot be forced as rapidly or as high as by skilled hand firing. Another serious disadvantage of mechanical stokers is that they are limited to certain grades of coal, which may also prove disastrous in case of strike. The dropping through of fine coal, either by step or chain stokers, gave rise to the design of special coal receivers built into the floor beneath the stokers. It cannot be denied that mechanical stokers have their advantages and good features, one of which, of especial value where superheaters are built into the boiler settings, is the avoidance of cold drafts due to the opening of the fire doors.

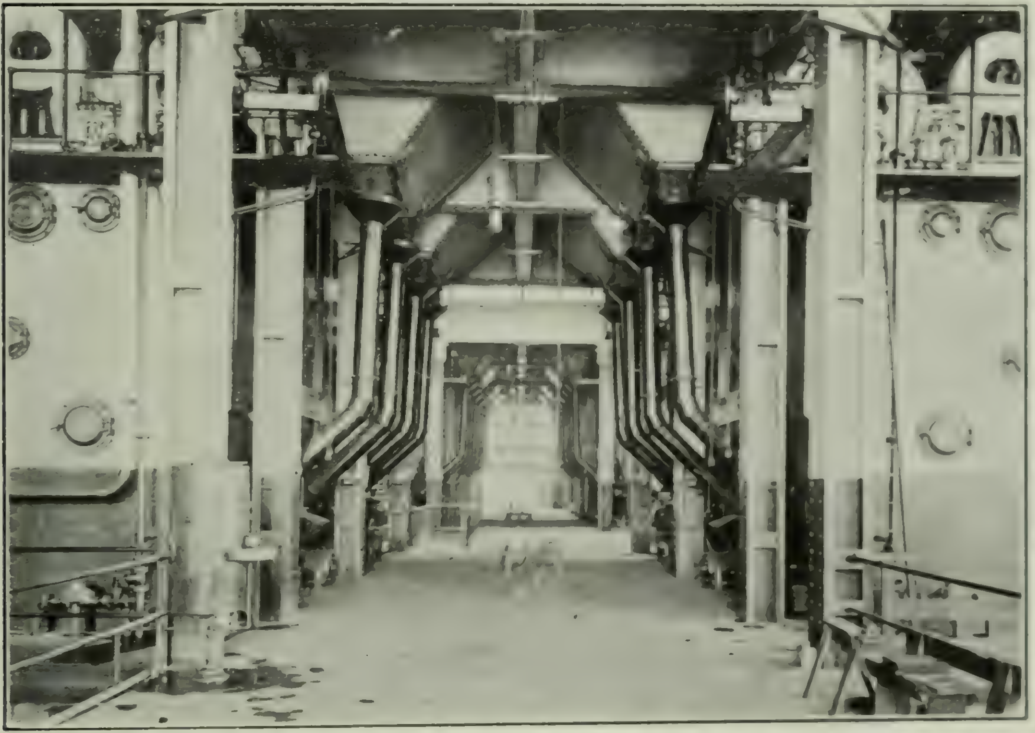


FIG. 28. NEW POWER STATION OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

The plant now comprises 18 water-tube boilers of 500 h. p. each served by 36 American Mechanical Underfeed Stokers. Four more boilers, with 8 stoker equipments, are being installed, raising the total to 11,000 h. p. The American Stoker Co.

It is often claimed that with the installation of stokers the smoke consumption is increased; this may be equally true with hand firing when in both cases a coking arch is installed. It is true that the more surplus cold air enters the furnace, the less complete is the smoke combustion. If the air entering the furnace chamber is previously heated, the combustion will be proportionately augmented. There are two different methods of supplying this air, either directly from the ash pit, usually not of high temperature, or through ducts in the boiler setting around the fire chamber. A good illustration of the first mentioned method will be seen in Figure 24, which represents a Leinhaas boiler equipped with Hering superheaters and Dubiau artificial water circulator and the above described smoke consuming device. As will be noticed the entire combustion chamber is covered, and at the end of the grates air is introduced and thoroughly mixed with the passing furnace gases, the heat produced at this point, on account of the smoke consumption, being so enormous that the tubes would be rapidly burned out did not the heavy reinforcement of the coking arch protect them. I feel confident that the combustion in this case would be incomplete if the air were drawn directly from the ash pit; but if, as previously suggested, the air is heated in ducts in the boiler setting or from the flue gases, a complete combustion would undoubtedly result. The decrease in the coal consumption is greater than generally imagined, and may be even 20 per cent, besides allowing a satisfactory use of the poorer grades of coal. By the introduction of steam into the furnace chamber, often used for smoke combustion, it must be borne in mind that the cost of operation is in-

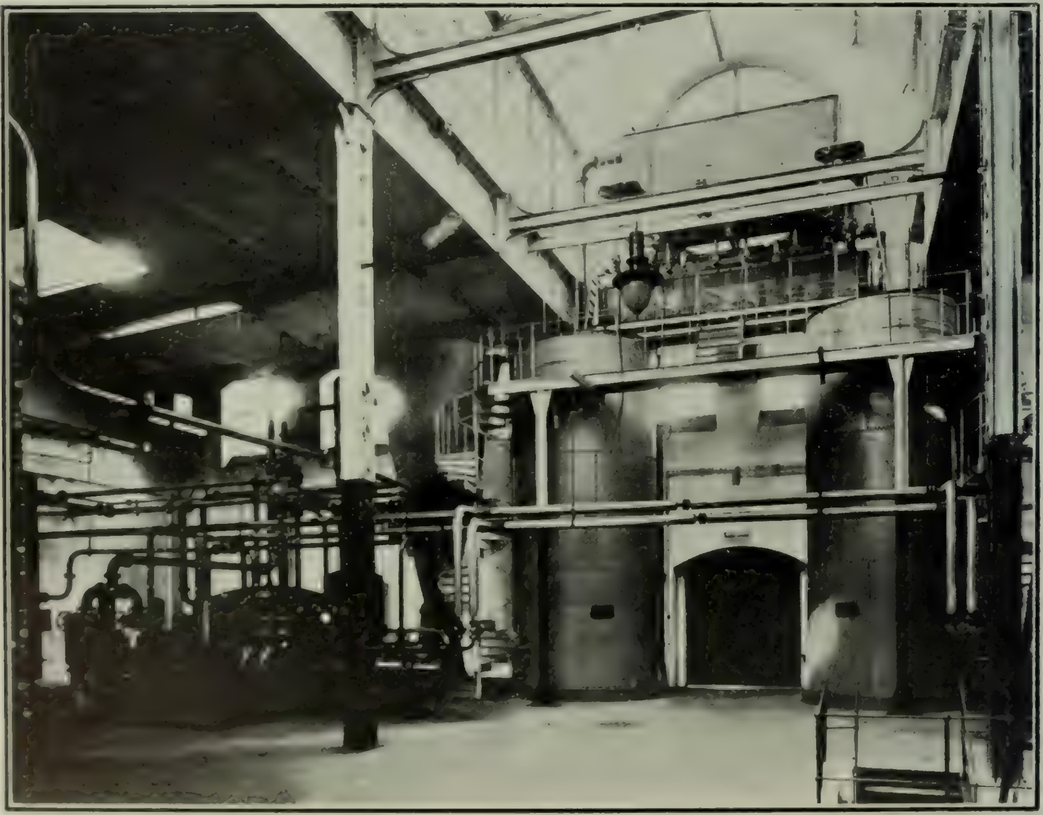


FIG. 29 DERVAUX-REISERT WATER PURIFIER, EACH OF 1,400-CU. FT. PER HOUR CAPACITY.

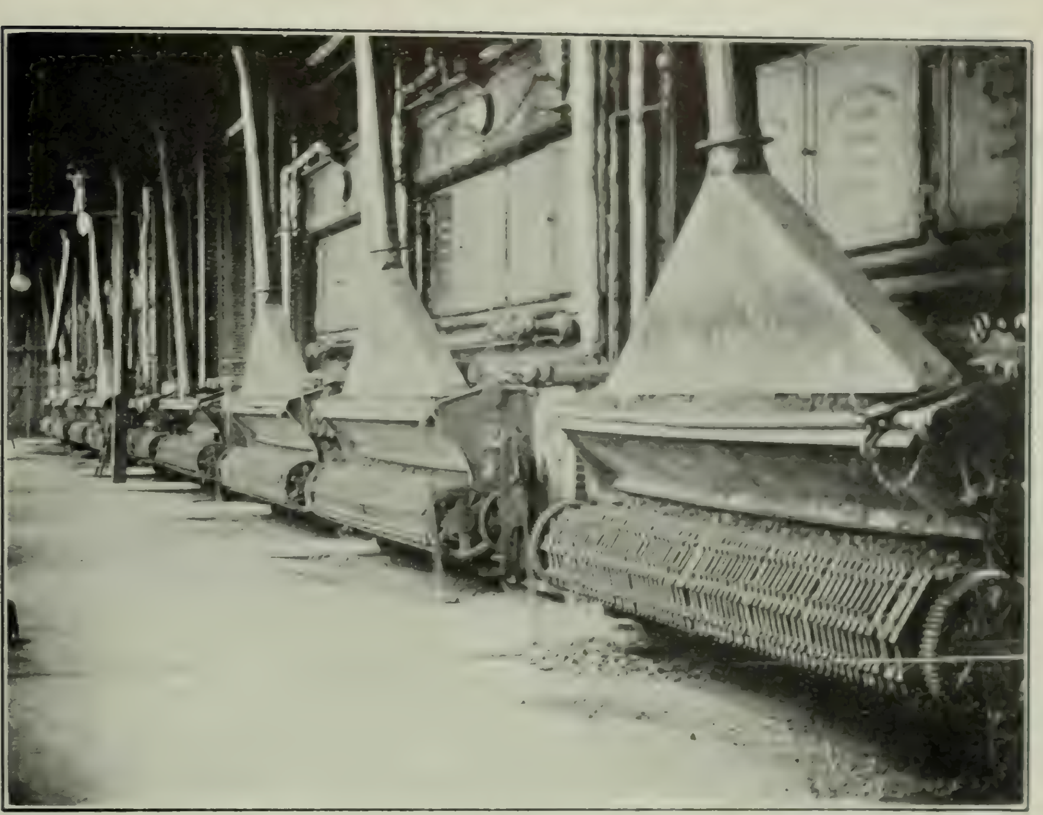


FIG. 30. BOILER PLANT, EAST ST. LOUIS & SUBURBAN POWER HOUSE, EAST ST. LOUIS, ILL.

Ten 575 h. p. Heine boilers arranged in 5 batteries, and equipped with Green traveling chain grates. Coal is fed from overhead bunkers, filled by conveyors direct from cars. Ashes are handled by conveyors beneath, discharging directly into empty cars. Heine Safety Boiler Co., St. Louis.

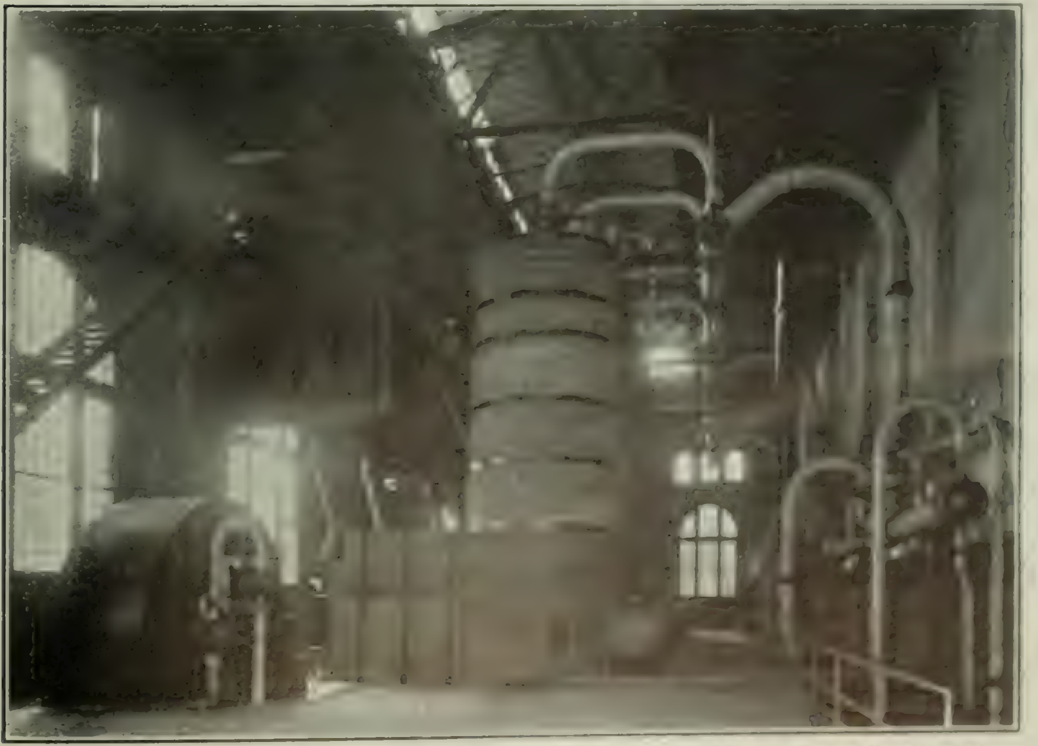


FIG. 31. BOILER-ROOM INTERIOR, PHILADELPHIA & READING R. R., READING, PA.

Eight 250 h. p. Wickes vertical water-tube boilers. Six more now being added. Wickes Bros., Saginaw, Mich.

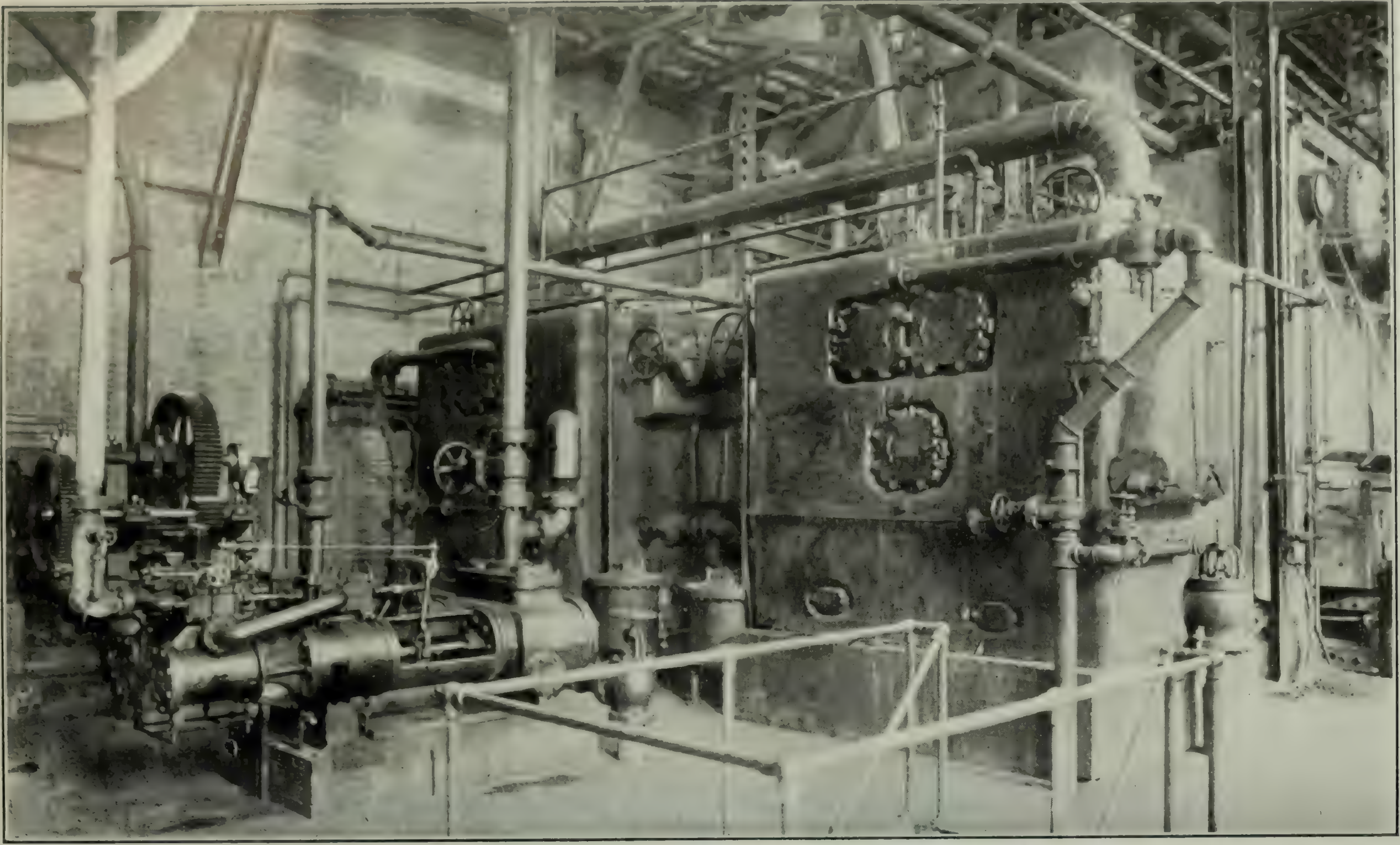


FIG. 32. SORGE-COCHRANE FEED-WATER HEATERS. POWER PLANT LOUISVILLE STREET RAILWAY COMPANY, LOUISVILLE, KY.

For heating and purifying water for 3000 h. p. of boilers. Harrison Safety Boiler Works, Philadelphia, U. S. A.

creased. This may also be said where steam is used to aid the natural draught in the chimney.

Mechanical, forced, or induced draughts also are found more frequently used in the United States than in any other country. This may also be due to the higher wages demanded by skilled stokers. Mechanical draught should replace the natural draught obtained with a high chimney. The former is comparatively more often found in connection with hand firing than with mechanical stoking, as a poor fireman needs the assistance of the blower. It may also be stated that with certain types of mechanical stokers, an uneven combustion may result from the use of mechanical draught. Of course, mechanical draught properly supplied has many advantages in certain respects.

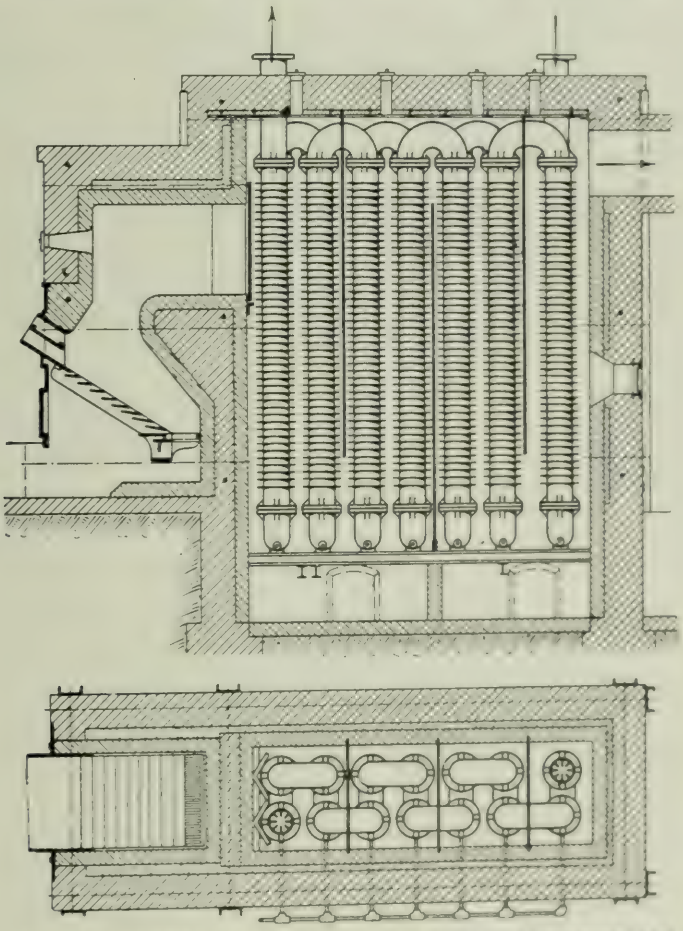


FIG. 33. SEPARATELY FIRED SCHWOERER SUPERHEATER.

V. BOILER FEED WATER.

As nearly all natural waters contain more or less impurities, it is of the greatest importance to purify the feed water before it enters the boiler. The foreign substances of most frequent occurrence are calcium sulphate and carbonate, magnesium carbonate, magnesium chloride, etc., all of which are the cause of more or less deposition of scale in the boiler, which is soon noticeable by reduced evaporation. The presence of this scale in boiler tubes increases the liability of burning out. The formation of scum and collection of mud in the boiler are also undesirable results of impurities, but although the bad effects of the latter may be easily overcome by frequent blowing off, this materially decreases the efficiency of the plant.

The first cost of a water-purifying system is not of great importance, and the larger the plant the cheaper comparatively it is. The cost of maintenance is also low, as the price of the chemicals generally used is small and it does not require close attention. All other work, such as the proportionate supplying of chemicals, is secured automatically and their thorough mixture is accomplished mechanically. It will be seen that an installation of this apparatus in an up-to-date plant will be of great benefit, and on account of the saving effected will soon repay the cost of installation. The accompanying illustration, Figure 29, shows an equipment of two feed-water purifiers with a capacity of 1,400 cubic feet per hour each.

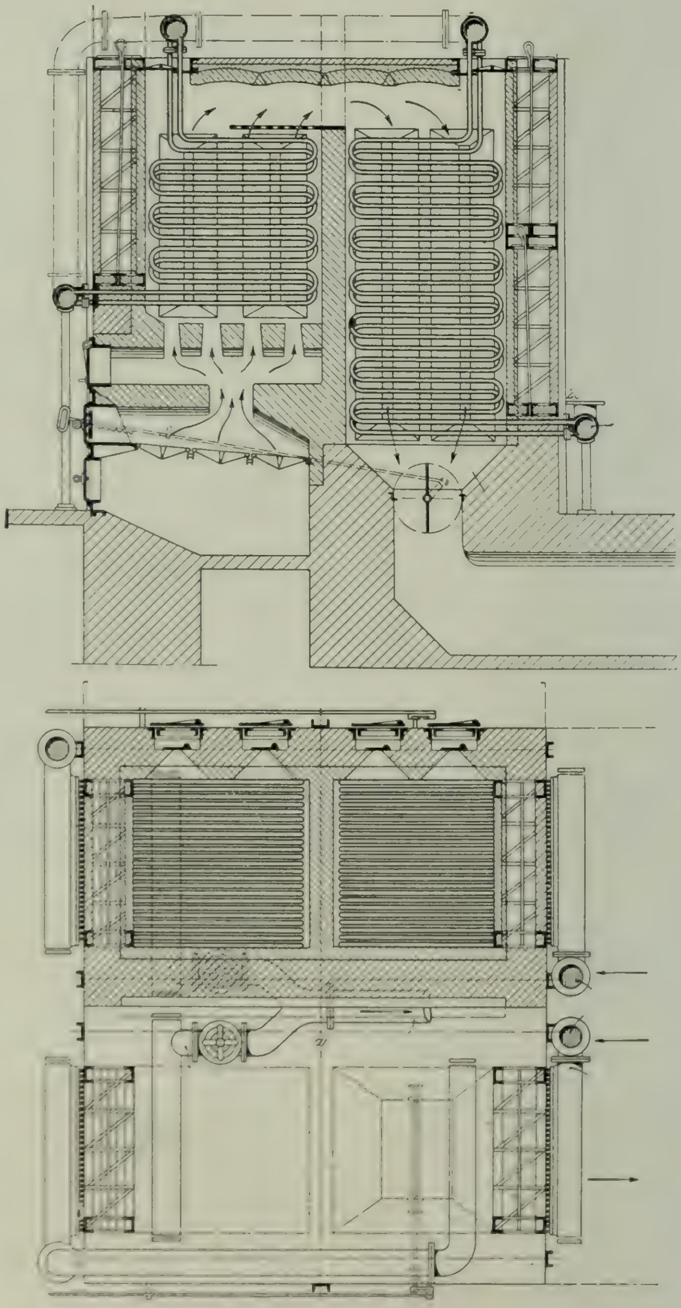


FIG. 34. SEPARATELY FIRED SUPERHEATER ON THE SYSTEM OF THE ASCHERSLEBENER MASCHINENBAU AKTIEN GESELLSCHAFT.

Not only will the purification of the boiler feed water assure an increased efficiency, but the benefit of raising the temperature previously to entering the boiler to a degree near the boiling point is to-day well recognized. This may be done by exhaust or live steam, or the waste boiler flue gases. By the utilization of exhaust steam with closed or open feed-water heaters, a temperature of some 190 degrees F. may be reached. When the feed water is heated by means of live steam, it must be borne in mind that the heat thus supplied to the water and returned to the boiler increases the life of the boiler, and the increased efficiency must not be underrated, provided the water is fed to the boiler in a short time, before the heat is dissipated. The only loss is that due to radiation in the steam pipes and the water tanks.

As the latest practice of prominent European engineers is the adoption of electric-driven auxiliaries for the condensing installation, only the exhaust from the feed pumps remains available for feed-water heating; and as this, in well designed plants, should not exceed ½ of 1 per cent; it will be seen that this is not sufficient to raise the temperature of the water to some 200 degrees F. The condensed steam itself at a high temperature may also be used as feed water provided it contains no oil. This practice may be followed also where a jet condenser is used, provided the circulating water is suitable for boiler purposes.

Where the escaping flue gases are at a temperature higher than is required for a good draught, the installation of economizers will be the best system for heating boiler feed water. Although the economizer, whether enclosed in brick setting or iron casing, requires a large floor space, its advantage in modern plants is well recognized. And when mechanical induced or forced draught is employed, one may take advantage of almost the entire heat in such a way that the discharging temperature is practically no higher than that of the atmosphere. Experience has proven that with a good and well set economizer, 240 degrees to 250 degrees F. and higher may be reached, and that the greater the waste of heat in the boiler itself, the greater the benefit of the economizer. From 10 to 15 per cent may be saved in the coal consumption, and to assure a still greater efficiency, the exhaust of the boiler feed pump (which is usually a good steam consumer) must be sent through coils into the cold-water storage tank, the pump being placed between tank and economizer. All pipe runs should be as short as possible, especially between the economizer and boiler, in order to reduce the condensation to a minimum. Pipes of this character in American practice are usually well covered in order to prevent the loss of heat, and frequently these pipes are made of brass. In Europe the old practice of making these pipes of highly polished copper is still found today, which method is claimed to be more efficient than the use of the best obtainable covering. This ex-

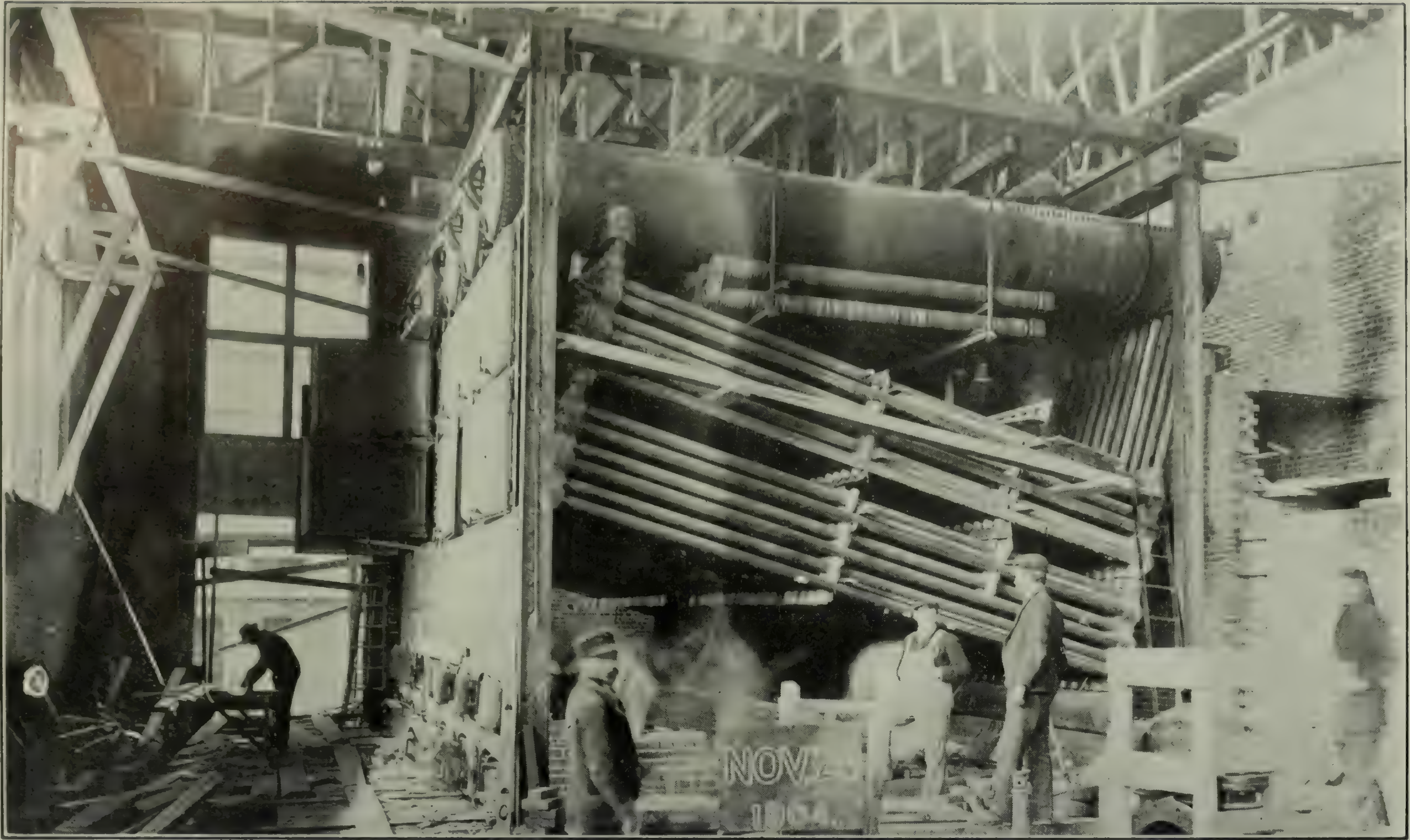


FIG. 35. FOSTER SUPERHEATERS. WATER TUBE BOILERS. SIX UNITS; 600 H. P. EACH; 165 LBS. STEAM; 100° SUPERHEAT. POWER SPECIALTY CO., 111 BROADWAY, N. Y.

At Hartford, Conn., Electric Light Station. A modern plant erected by The Westinghouse Kerr Co. and conspicuous for having used the first 1500 k. w. Westinghouse-Parsons turbine.

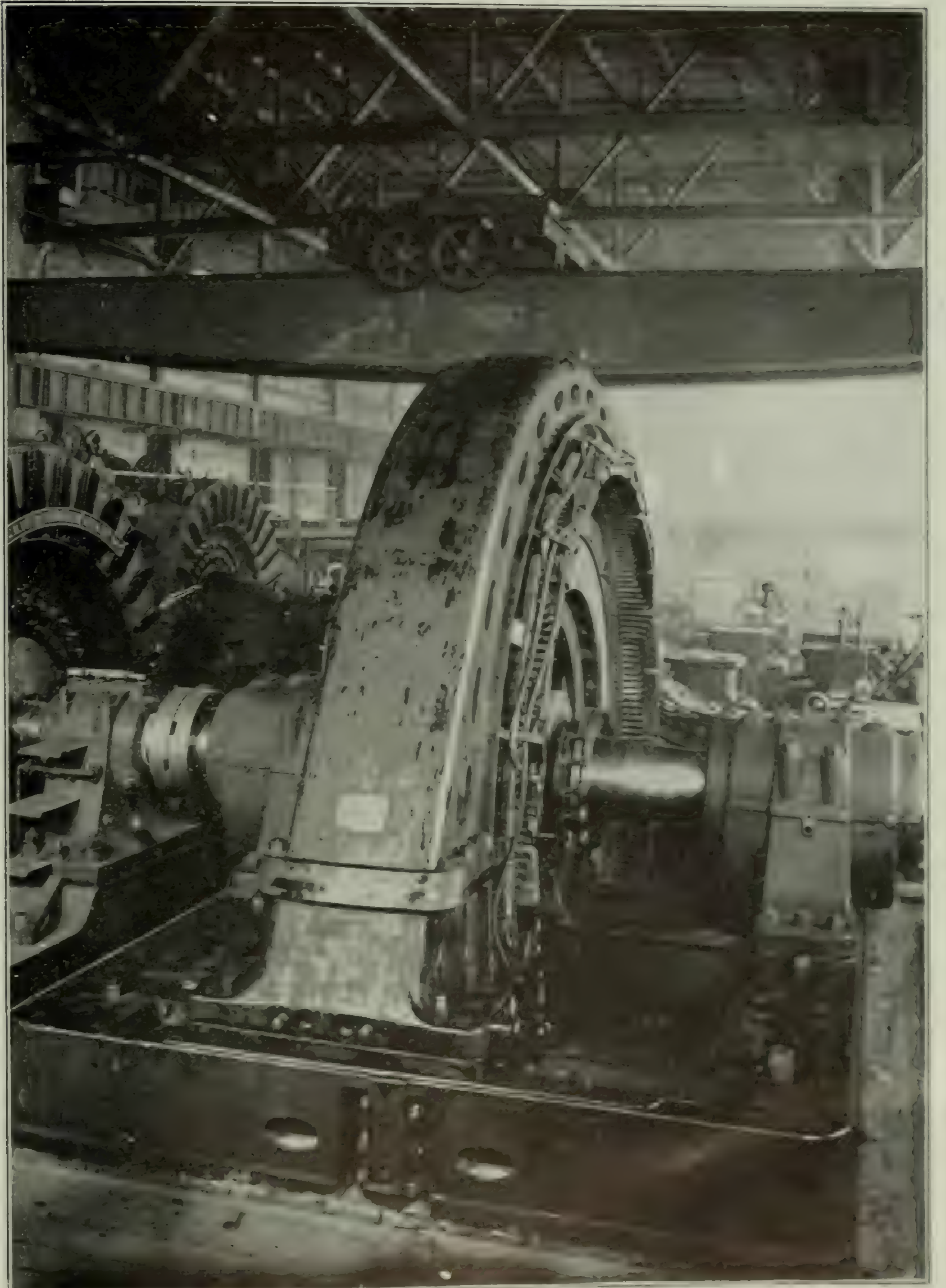


FIG. 36. 10,000 H. P. A. C. GENERATOR

Driven by water wheel, power house of the Ontario Power Company. Installed by Westinghouse Electric & Mfg. Company, Pittsburg, Pa., U. S. A.

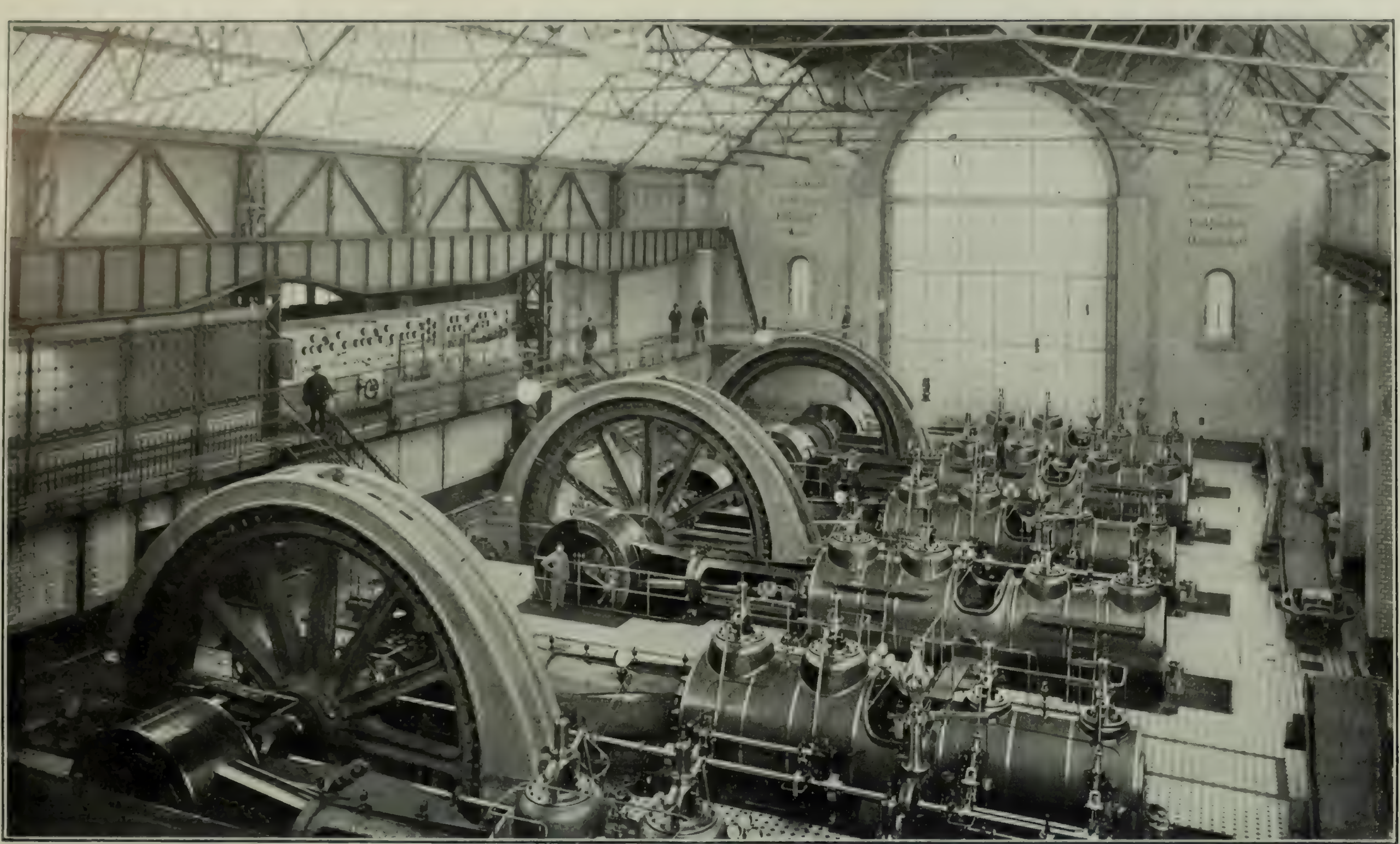


FIG. 37. THE MOABIT ELECTRIC-POWER STATION, BERLIN.

Containing four Sulzer Engines and Allgemeine Electricitats Gesellschaft Dynamos, the engines being of 3.000 horse-power each and fitted with triple-seated lift valves, and Sulzer valve gear. Installed by Gebruder Sulzer, Winterthur, Switzerland.

tem would still be in common use were it not for the introduction of superheated steam, which on account of its high temperature precludes the use of copper.

VI. SUPERHEATED STEAM.

Undoubtedly the most important feature in up-to-date boiler-house equipment is the utilization of superheated steam, the benefits of which are directly noticeable at the coal pile and water tank. It is well-known that the theoretical efficiency of an engine depends on the difference in temperature between the supply T_1, and the exhaust T_2, and since (as has often been proven on the continent of Europe) for each 9 degrees F. of superheat introduced to the engine the steam consumption may be reduced 1 per cent. it will be easily seen that the greater T_1 the higher the efficiency of the engine, provided it with

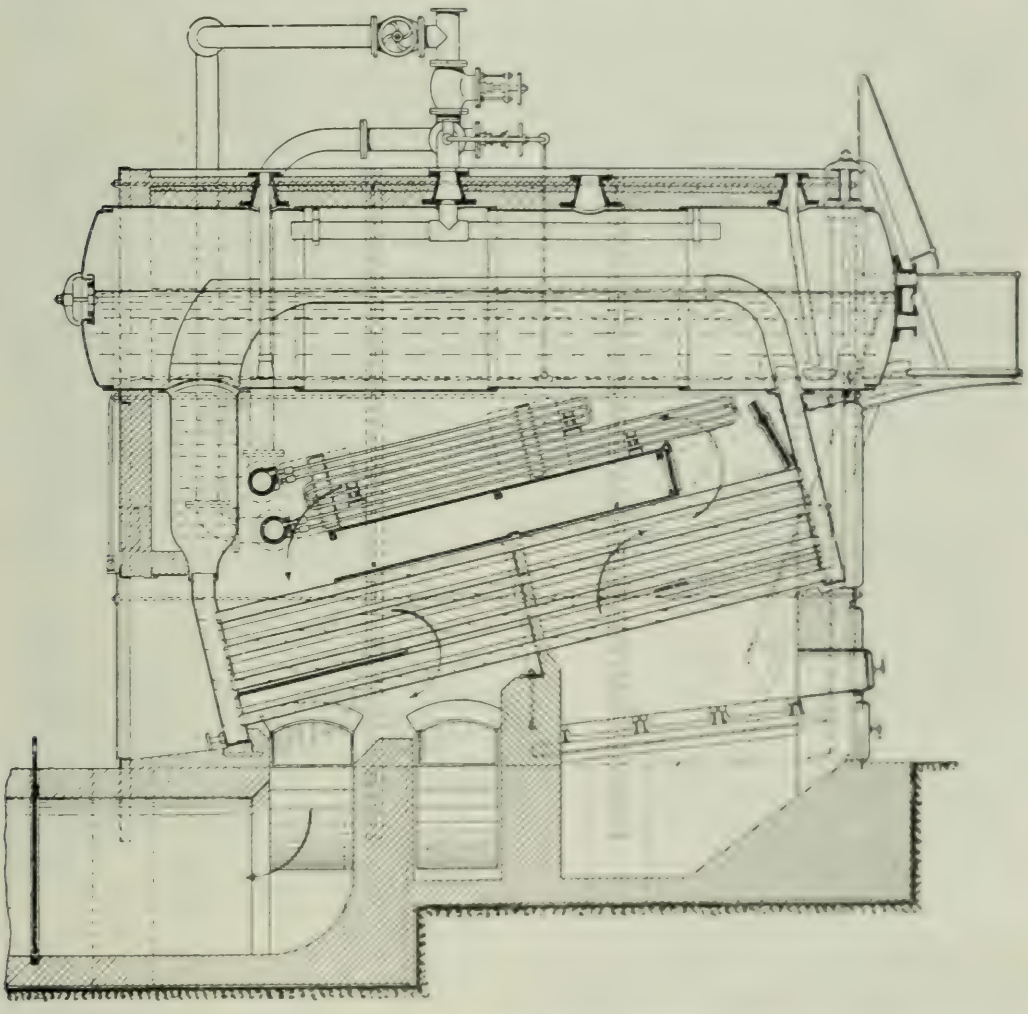


FIG. 38. BÜTTNER BOILER WITH SUPERHEATER

stands the heat. Another, though less important, advantage in the use of superheated steam, is the reducing of condensation in the mains.

The additional heat necessary to produce a given temperature of superheat depends entirely upon the design of the apparatus, and whether it is separately fired, or how located in the boiler setting. In order to determine the exact amount of heating surface required to produce a given degree of superheat, it is necessary to test each particular design of superheater under conditions similar to actual practice. The ratio of superheater to boiler heating surface required to produce a given temperature depends further on the amount of steam furnished per hour, on the steam pressure, and on the quality of fuel used.

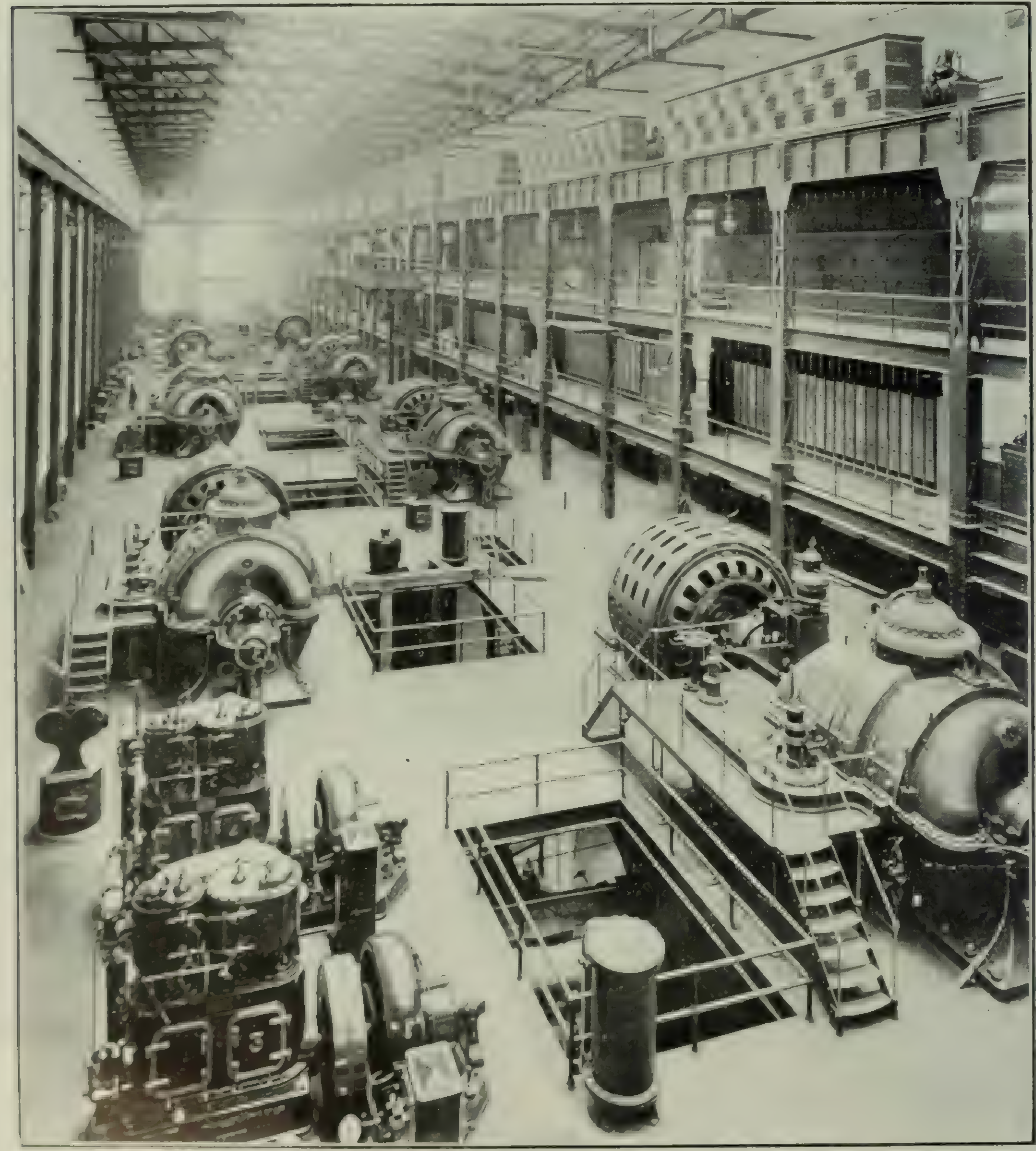


FIG. 37. CHELSEA POWER STATION, CHELSEA, ENGLAND. INTERIOR.

The enormous benefit of superheat may be shown in the following example:—Assuming an engine running with dry saturated steam and using 14 pounds per horse-power-hour; by the use of 135 degrees F. of superheat, according to the law already stated, the steam consumption would be reduced 15 per cent. to 11.9 pounds. Now, assuming the evaporation of 8 pounds of water per pound of coal, we need—instead of 1.75 pounds as in the former case—only 1.48 pounds in order to produce the required amount of dry saturated steam. With no surplus heat in the flue gases, we require in addition to this approximately 10 per cent (higher than average) of 1.48 pounds, making a total of 1.62 pounds, to raise the temperature of this steam to 135 degrees superheat, showing a saving of 7.4 per cent in coal consumption.

To give the financial aspects of a similar problem making the same assumptions as above:—Assuming a 5,000-kilowatt unit to run 24 hours a day and 360 days in a year the water consumption would be 2,960,000 cubic feet, which by the use of the above superheat would be reduced by 15 per cent, or 1,944,000 cubic feet, and as the price per 1,000 cubic feet is $1.00 there would be a saving of $1,944. For the same unit the annual coal consumption would be 50,652 tons, the use of superheat effecting a saving of 7.4 per cent or 3,748 tons, which at $2.50 per ton would amount to $9,370. This makes a total annual saving of $11,314, due to the use of superheated steam. As we have today plants of ten such units, the handsome saving of $113,140 would be effected annually by the use of superheated steam. Assuming sixty boilers to be necessary for the operation of this plant, and one superheater at a cost of $2,000 (a fair price) to be installed in each boiler, it will be seen that the total additional cost of $120,000 would be almost repaid in the first year leaving thereafter an ample saving, after making all allowance for depreciation, interest, etc.

The importance of the superheater is not generally recognized in the United States, as is evidenced by the fact that prominent plants have recently been constructed from which they have been entirely omitted, or in which only a low degree of superheat has been used. The objections often raised against superheaters are that the engine would not stand the increased temperature, or that their installation would not pay. The latter result might be due to improper choice of relative heating surfaces; the former would be due to poor design on the part of the engine, as this difficulty has been entirely overcome on the continent of Europe, where up to 300 degrees F. of superheat are frequently used both with reciprocating engines and turbines.

A case may arise where an increase in the capacity of a boiler plant is required, yet there is no space for an additional unit. This difficulty may be overcome by the introduction of superheaters. I recollect a plant in Gandersheim, Germany, where there were originally six boilers and it became necessary, apparently, to add one more. Instead, four Szamatolski superheaters were installed, enabling one boiler to be held in reserve.

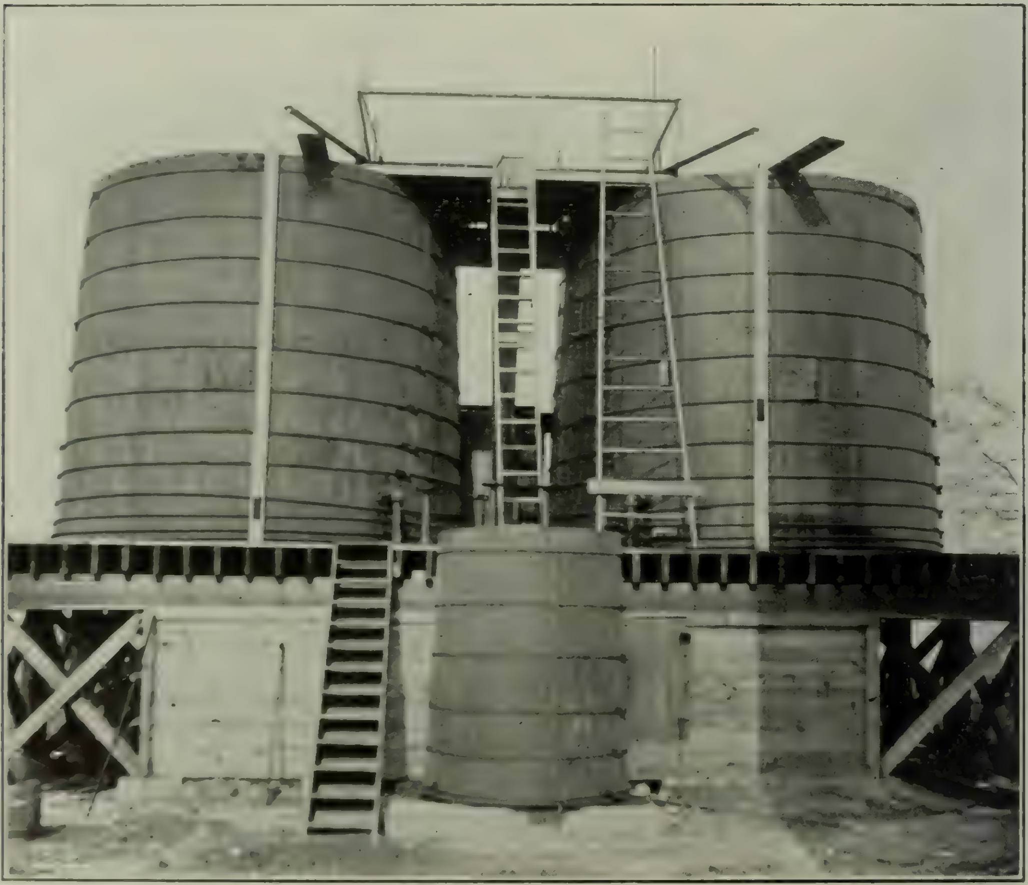


FIG. 40. WATER-SOFTENING AND PURIFYING SYSTEM AT GRAND RAPIDS, HOLLAND & CHICAGO RY. CO., JENNISON, MICH.

"We-fu-go" plant of 1,000 h. p. capacity, installed by Wm. B. Scaife & Sons Co., Pittsburg, Pa.

There are two types of superheaters—steam-tube, in which the steam passes through tubes surrounded by flue gases, and, flue-gas superheater, in which the flue gases pass through the tubes surrounded by steam. The latter type generally exhibits a flat, box-like construction, in which a number of staggered rows of short tubes are placed. The design is comparatively recent.* These superheaters may be sub-classified as dependently and independently fired, a choice between these latter two depending entirely upon the power plant design.

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* Berlin Zeitschrift des Vereines Deutscher Ingenieure.

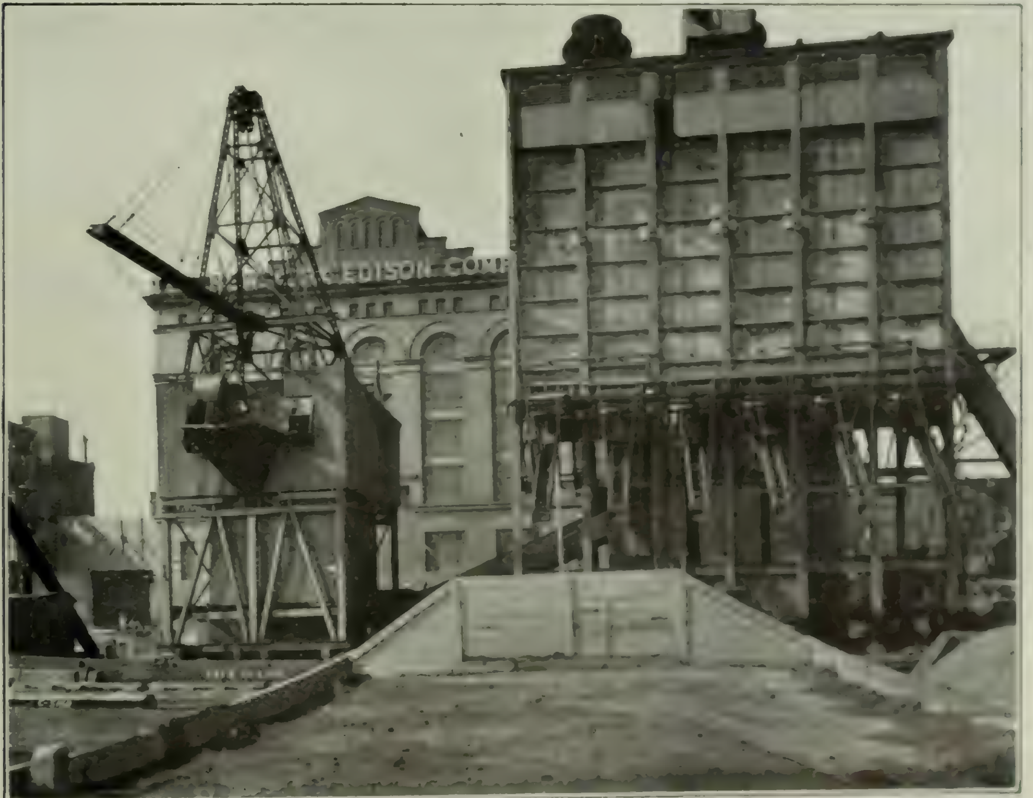

FIG. 41. COAL-HANDLING INSTALLATION, NEW YORK EDISON COMPANY'S WATERSIDE POWER STATION, EAST RIVER

Steel unloading tower on wheels; direct-acting hoisting and trolley engines, 14 by 14 and 10 by 12 respectively; coal passes from hopper through single crushing roll driven by 10 by 10 engine; thence is handled by belt conveyors to suspended weighing hoppers, and from there by another conveyor to boilers. Capacity, 3 to 4 tons per minute. The Mead-Morrison Mfg. Co., N. Y.

The large majority of steam-tube superheaters are made up of a number of return bends or tubes of small diameters, of steel or wrought-iron. The intention in this type is to divide the steam into many parts, forcing them at high velocity through the tubes, thus bringing all the steam into close contact with the heating surface. The thinner the walls of the tubes the more rapid the transfer of heat; but as these tubes are also easily affected by cold draughts, more skilful attendance is required than with the heavier construction. There are some types on the market of such heavy construction that it is unnecessary to flood them or shut them off by means of dampers before steam is generated. The regulation of the superheat may be accomplished by means of dampers (Figure 38) controlling the flue gases, by mixing the superheated steam with dry saturated steam, or by having water tubes concentrically located in the steam tubes of the

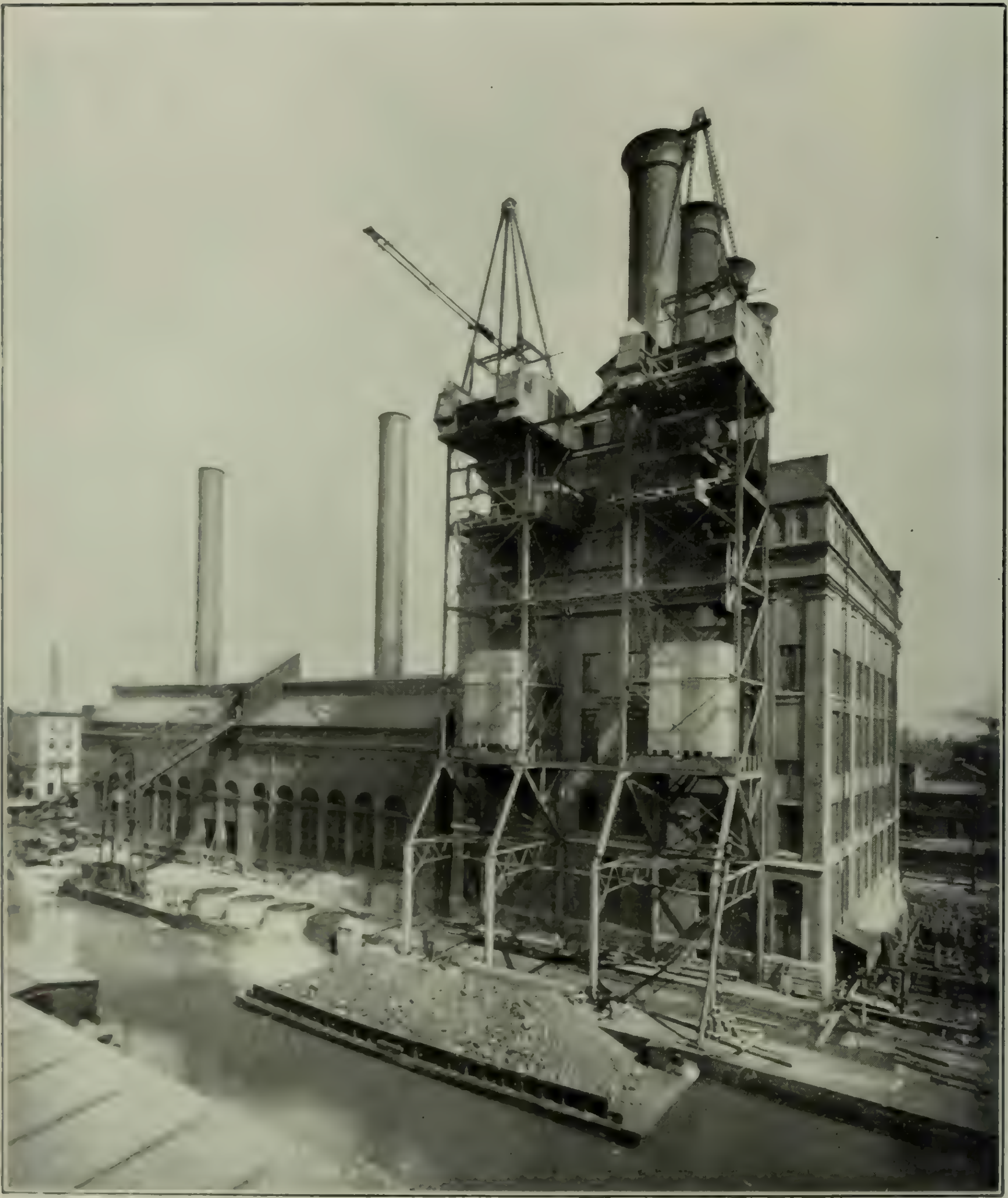

FIG. 42. COAL AND ASHES HANDLING STATION OF THE UNITED RAILWAYS AND ELECTRIC COMPANY, PRATT STREET STATION, BALTIMORE.

Installed by C. W. Hunt Company, West New Brighton, N. Y., U. S. A. Power house capacity is 19,500 h. p. Tall building at the right hand is old station, and extension on the left is new, embodying all progress in power house engineering to date. No hand labor is required in handling coal or ashes, the system being automatic in all its functions.

superheater, as in the Cruse type. Cast-iron superheaters are not much in use, in spite of the many attempts made to perfect them. In Germany, where the use of superheaters has been most extensive, only one cast-iron type, the Schwoerer (Figure 33), has been successfully used, and that on account of a secret process. It is natural that a heavily constructed superheater is more suitable to a careless boiler operation or as independently fired type.

Practice has proven that the operation of a superheater is more efficient when the steam and flue gases travel in opposite directions, thus bringing the wet steam into contact with the flue gases at the lowest temperature, while in leaving the heater the steam comes into contact with the hottest gas. This not only reduces the coal consumption but also greatly increases the life of the superheater, although a case may arise where the flue gas and steam may favorably flow in the same direction. A flue-gas temperature of 500 degrees C. (932 de-

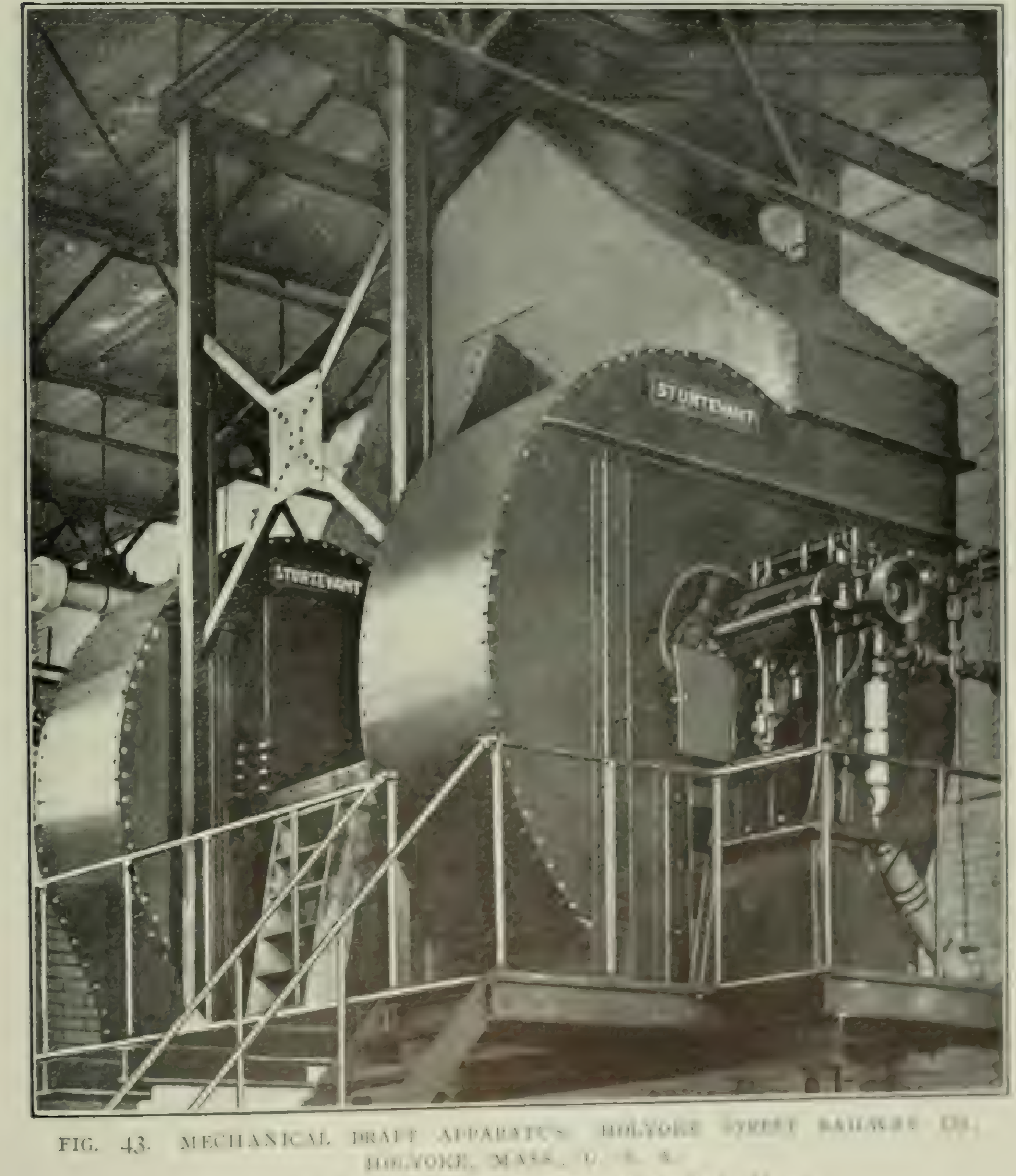

FIG. 43. MECHANICAL DRAFT APPARATUS: HOLYOKE STREET RAILWAY CO., HOLYOKE, MASS., U. S. A.

Installed by B. F. Sturtevant Co., Hyde Park, Mass.

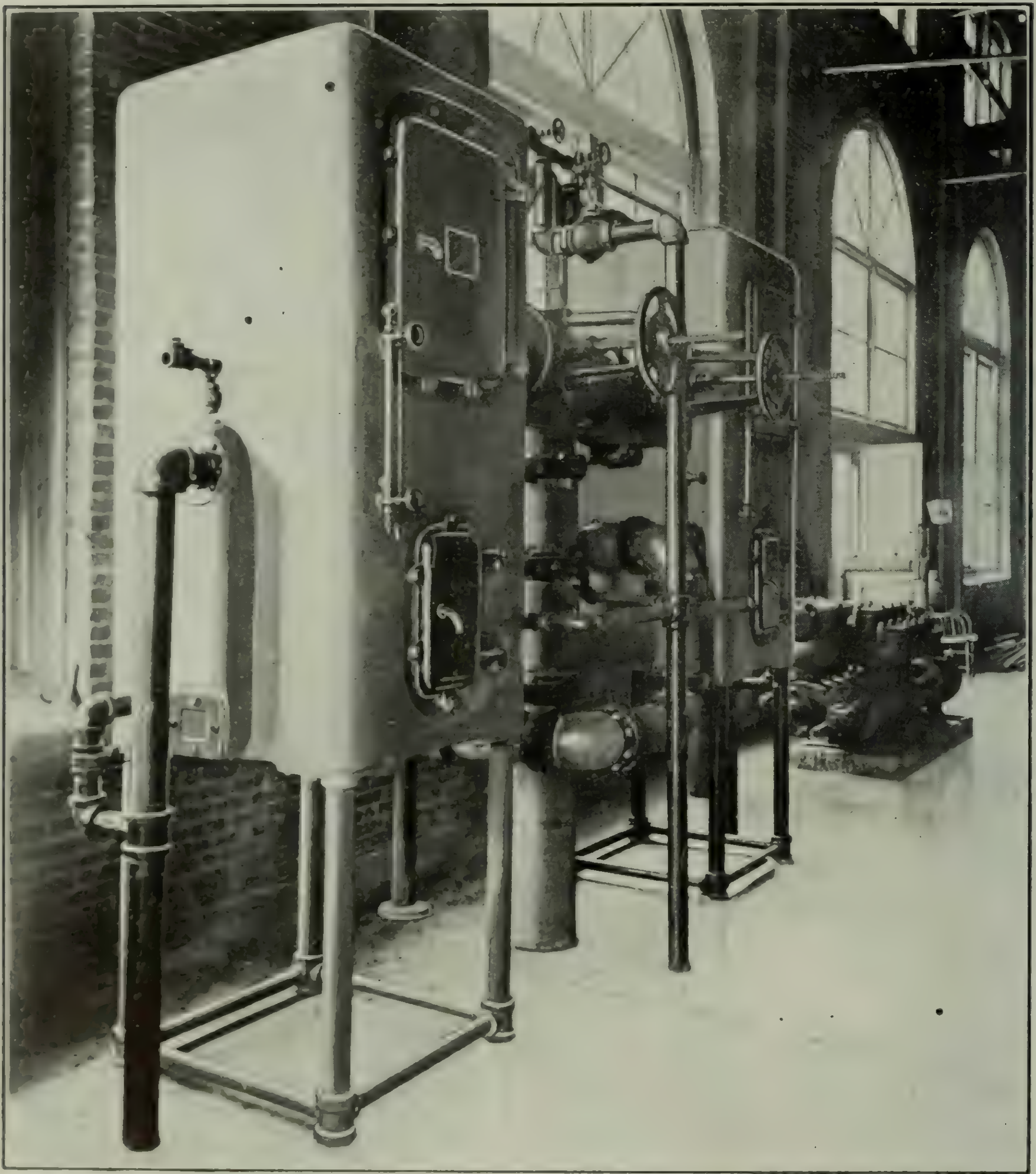

FIG. 44. WATER HEATING INSTALLATION, POWER HOUSE OF THE PENNSYLVANIA R. R. CO., CAMDEN, N. J.

Warren Webster & Co., Camden, N. J.

grees F.) may not damage a well built superheater, provided a proper flow of flue gases and steam is obtained. At 600 degrees C. (1,112 degrees F.) and higher, Berner*, probably the best authority on superheaters, recommends parallel current, or a combination of parallel and counter current.

VII. STEAM PIPES AND COVERING.

The steam mains are the arteries of the mechanical part of the plant, as the wiring is in the electrical part, and must be so designed as in case of a local failure to feed the prime movers through by passes at the shortest notice. This can be done not only by installing the best fittings, but by adopting the most flexible yet short pipe system. We may consider three systems of pipe layouts, viz., the single header, the multiple header, and the ring system, the principles of which I gave in my article on steam pipes in modern power plants* as follows:-

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* Berner, Zeitschrift des Vereines Deutscher Ingenieure.

"The single-header system usually consists of a line which is run at the back of or above the boilers, and to this are connected the lines from the boilers, the connection either entering at the side or dropping from above the main header. The arrangement of valves in the boiler lines is such that any boiler may be disconnected from the header at will. The steam lines to the engine or turbines are taken from this main header, usually from the top, and are thence led to the prime mover. The disposition of valves, both in the main line and in the branches, should be of a character to insure flexibility in operating and to enable the steam to be drawn from any or all of the boilers, as may be necessary, and also to enable the line to any engine to be dis-

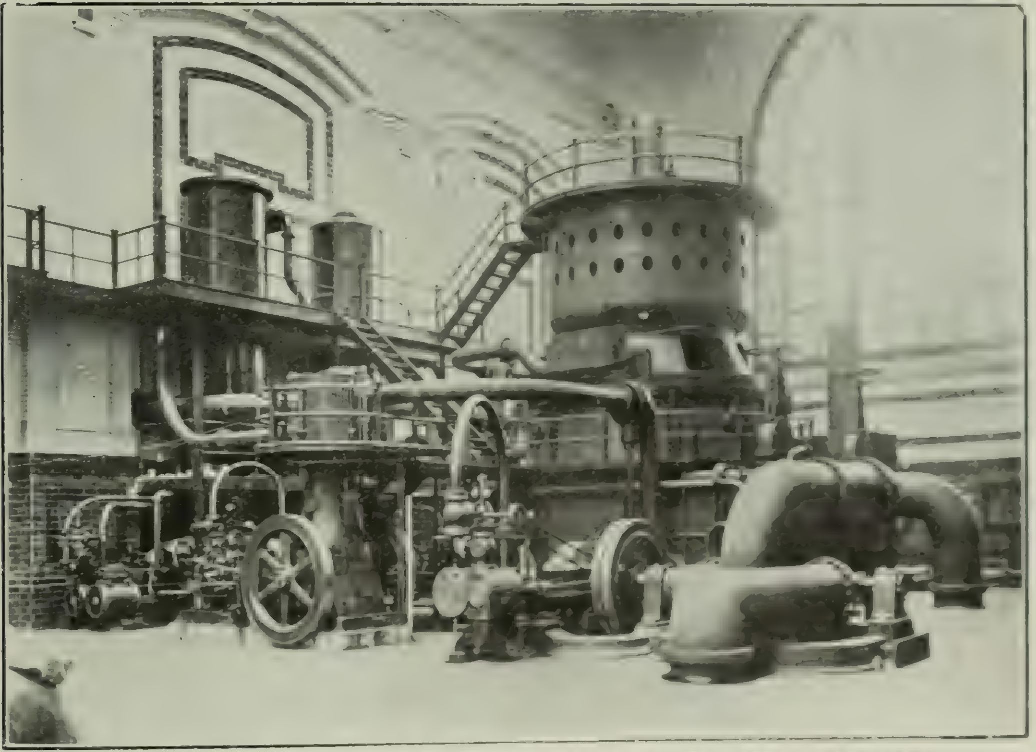

FIG. 45. 5,000 K. W.—514 R. P. M.—5-STAGE CURTIS STEAM TURBINE

Direct connected to ATB 14—5,000—514—6,600 Volt Generator, installed in power house of the Edison Electric Illuminating Co., Boston, Mass., by the Edison Electric Company, Schenectady, N. Y., U. S. A.

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* *The Street Railway Review.*

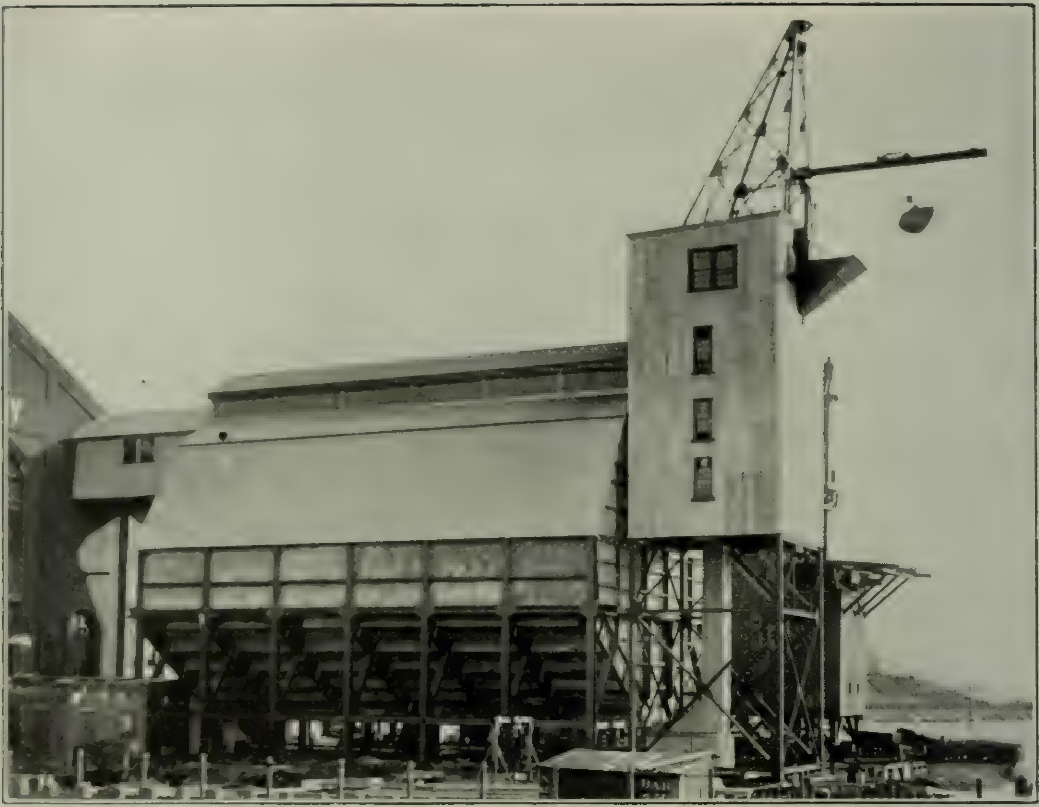

FIG. 46. COAL-HANDLING PLANT AT THE POWER STATION OF THE BROOKLYN EDISON CO., N. Y.

Plant comprises 80-ft. unloading tower, 3000-ton main storage pocket, storage bins over boiler room, electrically operated shuttle cable road with cars of 3-tons capacity, and McCaslin gravity-bucket conveyor, fed at six points and dumping automatically. Roof of galvanized iron and wire glass. The Mead-Morrison Mfg. Co., N. Y.

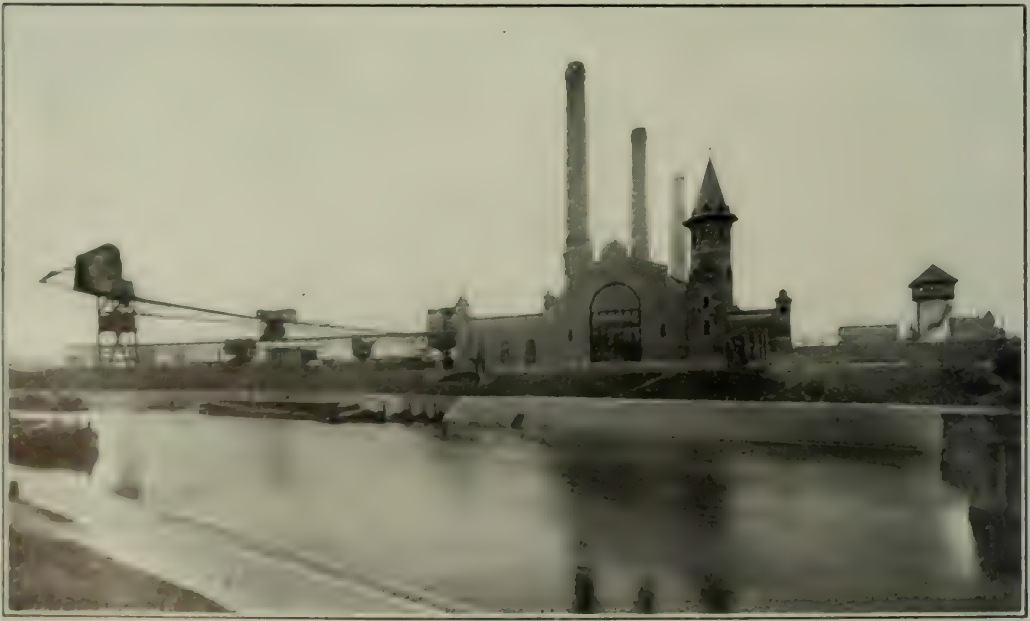

FIG. 47. BERLIN ELECTRICITY WORKS POWER STATION, MOABIT.

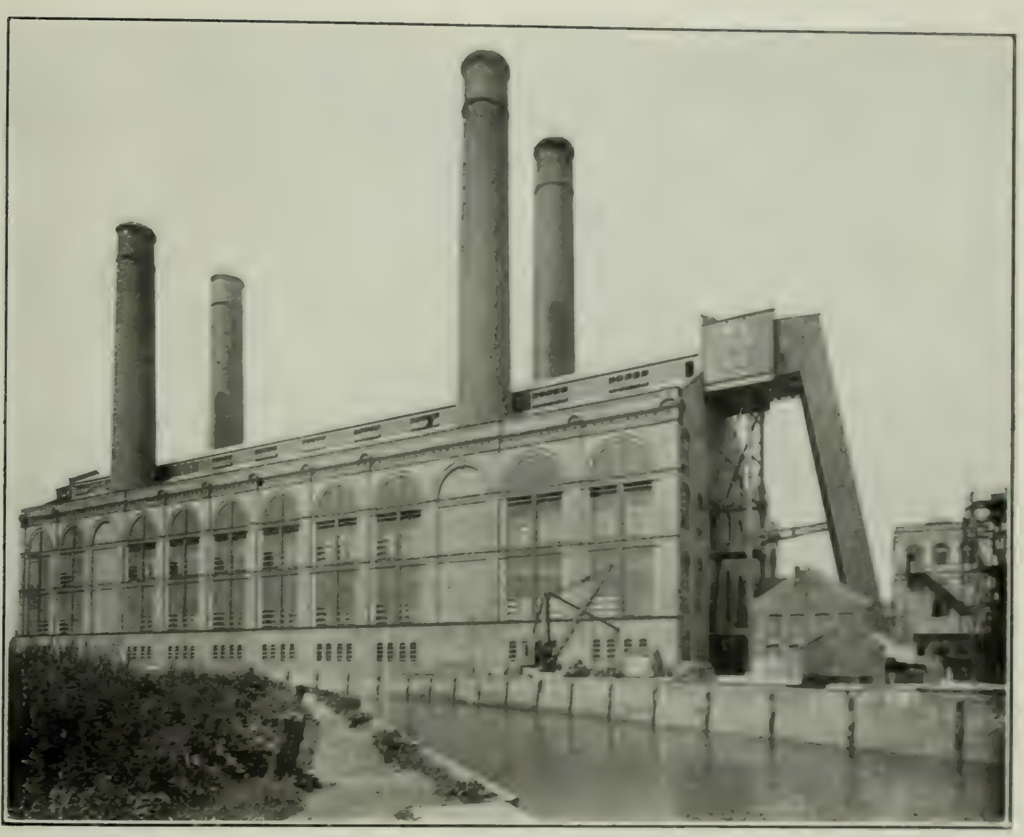

FIG. 48. CHELSEA POWER STATION, CHELSEA, ENGLAND. EXTERIOR.

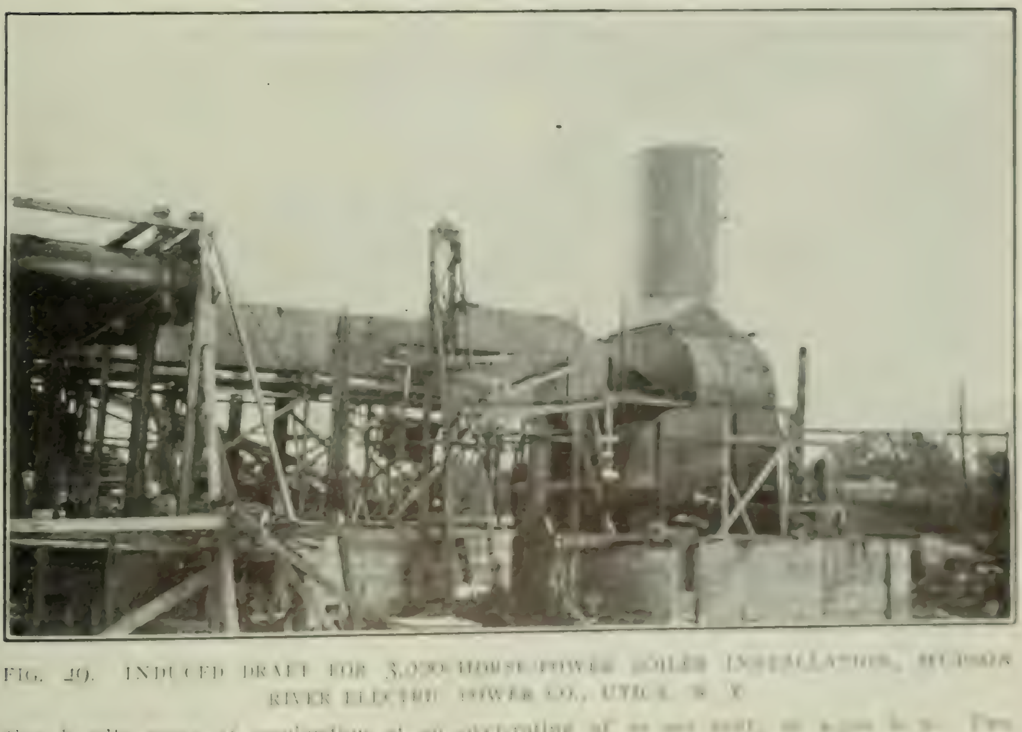

FIG. 49. INDUCED DRAFT FOR 3,000-HORSE-POWER BOILER INSTALLATION, HUDSON RIVER ELECTRIC POWER CO., UTICA, N. Y.

Can handle gases of combustion at an overrating of 50 per cent, or 4,500 h.p. Two 260-in. full-housed fans, each with 15 by 16 horizontal center-crank engine. Inlet, 112½ in. diam. outlet, 134 by 78 in. 180 r.p.m. American Blower Co., Detroit.

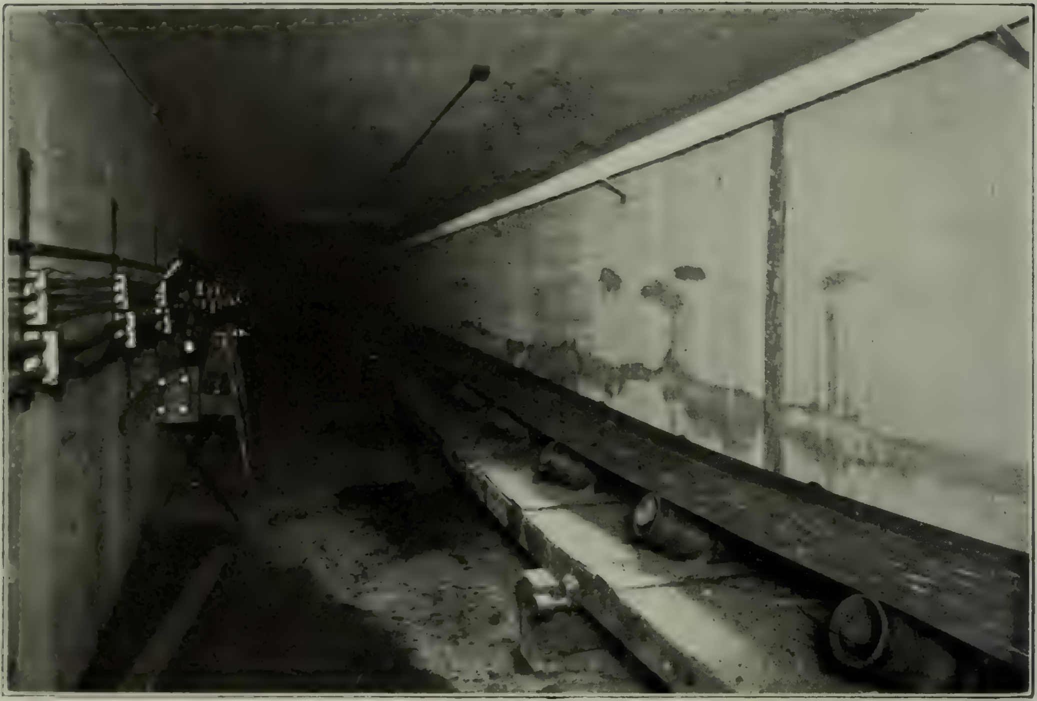

FIG. 50. COAL CONVEYOR IN TUNNEL AT THE SUBWAY POWER PLANT OF THE INTERBOROUGH CO., N. Y.

30-in. belt, speed 350 ft. per minute; designed for hauling 250 tons of crushed coal per minute, but exceeds that capacity. Robins Conveying Belt Co., N. Y.

connected at will. The general character of this system is well known and needs no further description. On account of the extreme simplicity of this method it is very largely used. The pipe connections to and from the super-heaters are also given.

"The multiple-header system consists of two or more headers to which the connecting pipe lines from the boilers are joined, and from which branches are led to the engines. The general arrangemnt of this system is shown in Figures 3 and 4, and from these diagrams it will be seen that the arrangement of connections is a remarkably flexible one, and that the method provides as far as possible against accident to any part of the pipe line. Two possible methods of cross-connecting are shown in these illustrations, and it will be seen that in the right-hand method flexibility is purchased at the cost of numerous valves and fittings. It is, of course, apparent that there are almost an infinite number of ways in which the multiple headers may be cross-connected, but in any event the object of this system is to provide an extra header to carry the load in case of an emergency, and the best method of cross-connecting is that which utilizes the minimum number of valves and fittings and at the same time is the most flexible. "The general arrangement of the ring system is to construct the main steam header in the form of a closed ring. This ring may be split up into sections by means of suitably placed valves. There are numerous variations possible with this arrangement, as where the header runs around both sides of the boiler room the two sides may be cross-connected at desirable points, or where the two sides of the ring are close together, and, on account of the effect of expansion in a short cross-connection, the two lines are only joined at the ends by short bends."

Pipe sizes should be chosen as small as possible without ill effect, since small pipes are cheaper, lighter, and more convenient.

In American practice the velocity of the steam in the main does not usually exceed 6,000 feet, or about one mile per minute, while in Europe the velocity is often as high as two miles, on account of the use of superheated steam. Superheated steam is a more perfect gas and is not so easily affected by friction at elbows, bends, valves, etc.; therefore the loss in pressure is much less than in the case of saturated steam, of which the specific gravity is much greater. On account of these qualities it is much easier to convey superheated steam at greater velocity than ordinary steam, and therefore smaller pipes may be used. It may be of interest to give the following examples show-

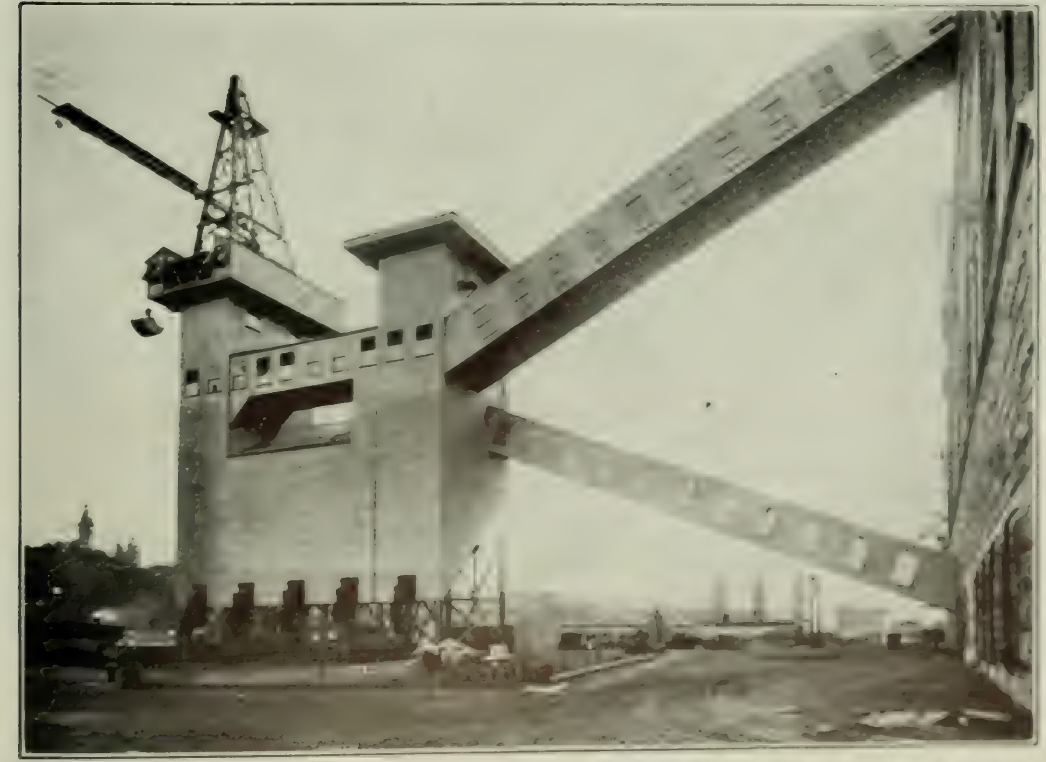

FIG. 51. KINGSBRIDGE POWER PLANT OF THE THIRD AVENUE RAILROAD CO., NEW YORK.

Hoisting and conveying apparatus designed and installed by the Robins Conveying Belt Co.

ing the marked difference between the practice in America, in England and on the Continent. The four 5000-kilowatt Brown-Boveri-Parsons turbines in the St. Denis plant, Paris, are each supplied by one 12-inch steam pipe. The 5,000-kilowatt Westinghouse Parson turbines in the Chelsea plant, London, are suplied by 14-inch pipes. The 3,400-horse-power Sulzer engines in the Vienna stations are supplied by 8-inch pipes. On the other hand, the 8,000-horse-power Allis Chalmers engines in the power plants of the Elevated and Subway roads in New York are each supplied, as they are four-cylinder cross compound, by two 14-inch pipes. At the last mentioned station there are two Westinghouse marine type engines, supplied by 8-inch mains. A better showing is made by the recently erected Westinghouse-Parsons and Curtis 5,000-kilowatt turbines at different stations, each of which is supplied by one 14-inch main.

With the adoption of high pressure up to 200 to 300 pounds, and superheated steam up to 500 degrees or 750 degrees F., and even higher, it will be seen that the old standard fittings are no longer of value for modern power-plant practice. Thus it happens that many prominent power-plant engineers in the United States have adopted their own fittings, especially flanges. It is very different on the Continent, where the Verein Deutscher Ingenieure has adopted standard flanges for pressures up to 20 atmospheres per square centimeter (294 pounds per square inch) which have today been accepted through practically the entire Continent. These standards include many different designs. Those mentioned below are the most favored. The dimensions in the accompanying table suitable for 300-pound pressure, originally given in metres, have been changed to read in inches and fractional parts, and have been slightly increased over what the converted dimensions would be, to do which the author has laid out each individual size of flange. Also well known and quite extensively used are the tongue-and-groove joint and a lens joint, the latter having a round gasket. The lens joint may be practically adapted either for the use of a gasket or for a ground steam-joint. The ground joint is more common in America than in Europe, where grooved joints fitted with gaskets are favored. The re-enforced end of the pipe is of the same material as the main pipe, and welded on. Tight joints are always attainable by use of any of these types.

A table of flanges compiled by Mr. John Van Vleck, has been adopted by the Interborough Rapid Transit Company and also by several other engineers. These flanges are designed for the use of ground joints only.

	Pressure in lb.	Pipe Size, inch.	Flange Diam., inch.	Thickness, inch.
Verein Deutscher Ingenieure.............	300	8	14¼	1⅛
American Society of Mechanical Engineers	250	8	15	1⅛
Interborough Rapid Transit Co...........	250	8	16½	2

The practice of using drawn or seamless welded wrought-iron or steel pipes for conveying steam is old, and the elasticity necessary on account of expansion and contraction, especially with the use of superheated steam, is well-known. In place of the old type of cast-iron elbows, long sweeping bends, generally of a radius not less than five times the pipe diameter, are now installed. Cast-iron or special steel fittings are still in use where the space is limited, or when fittings of special design are required. In Continental plants one will quite often find these fittings replaced by welded ones, which are obtainable for any desired pressure, size, or pattern, with either fixed or moveable flanges. For example, steam collectors, with some dozen nozzles, or complicated pipe headers, and elbows similar to small standard cast-iron types, are welded as if made of a single piece. The material for these fittings is usually either Siemens-Martin or Thomas steel. Harder plates may also be welded for this purpose, but their use is

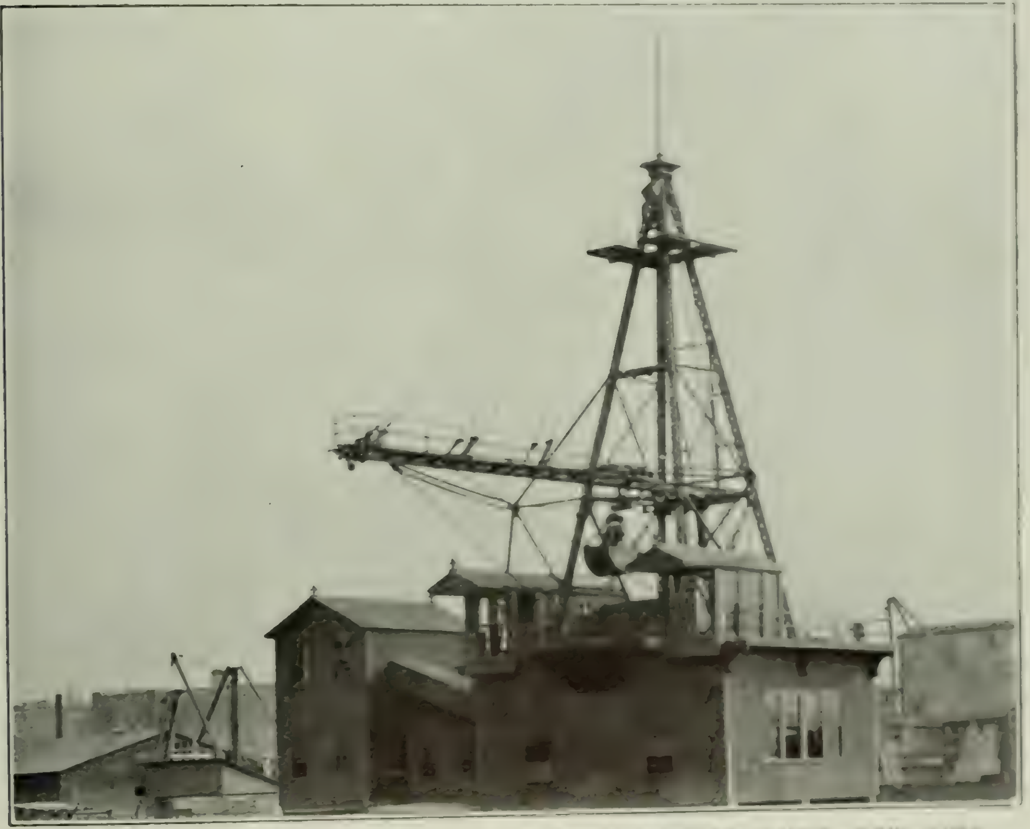

FIG. 51. ELECTRIC HOISTING TOWER AT SUBWAY POWER HOUSE, NEW YORK.
Erected by the Robins Conveying Belt Co.

limited. These different welding processes are carried on by a great number of firms, and are no longer secret.

Continental pipe designers, in choosing pipe lengths, are not so much handicapped as in the United States, where pipes a trifle more than 20 feet in length are the longest obtainable. They can obtain pipes up to about 50 feet in length without special difficulty. The advantages of avoiding numerous flanges and of using fittings as above mentioned, of the same material are well realized by men experienced in this line.

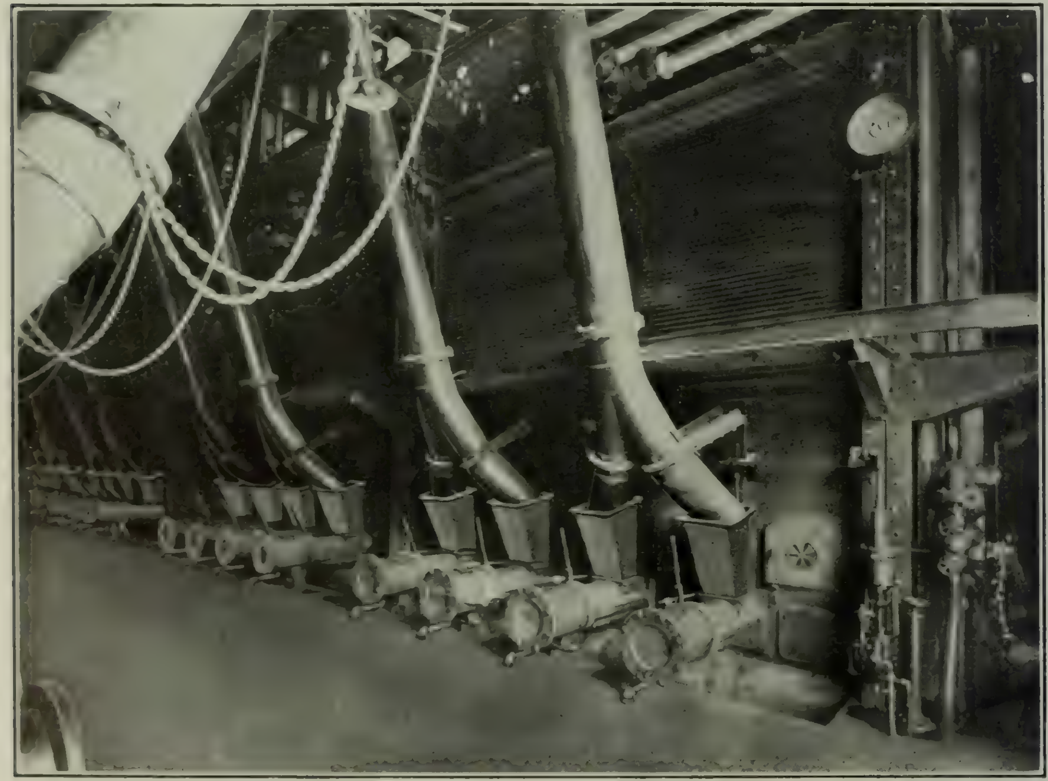

FIG. 52. COMMERCE ST. STATION, MILWAUKEE ELECTRIC RAILWAY & LIGHT CO.

Jones Stokers supplying Edgemoor water-tube boilers of 650 h. p. each. An additional equipment of 32 Jones Stokers is being supplied to this station. The combined plants of this electric company have 11,200 h. p.. The Underfeed Stoker Co. of America, Chicago.

As already stated, the pipe lines connecting boilers with prime movers must be as short as possible. As in modern engineering practice and with the improvements in material the liability to breakdowns has been reduced to a minimum, a single common emergency line (header) should prove satisfactory. It is of the greatest importance though seemingly often overlooked) to cut *dead* all lines not required for the direct operation of the engines in order to avoid any unnecessary condensation; by so doing we may materially increase the econ-

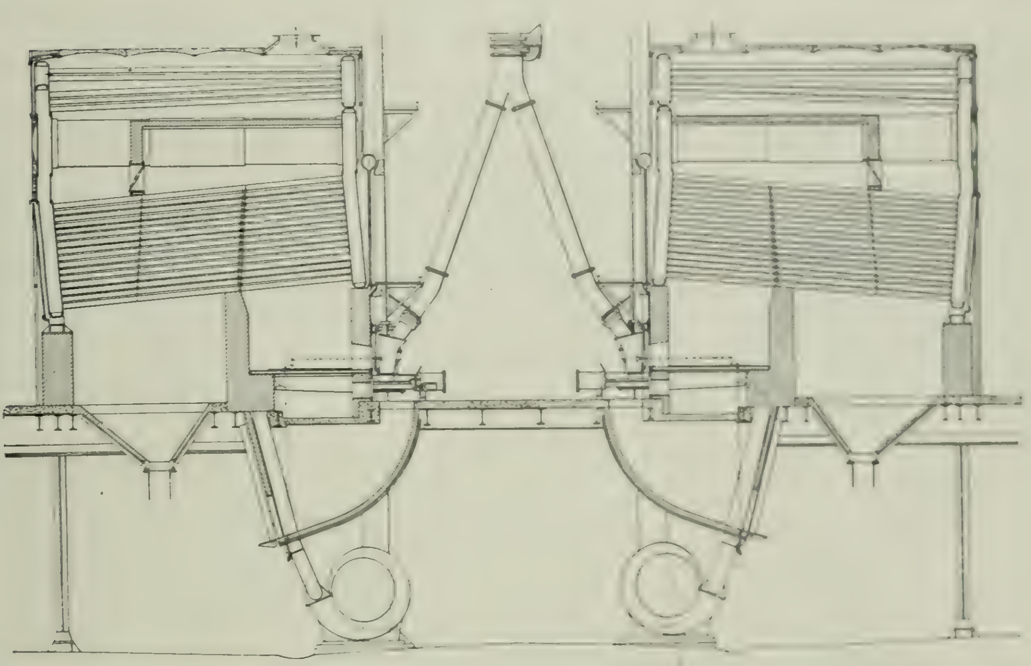

FIG. 53. CROSS SECTION SHOWING INSTALLATION OF COAL-CONVEYING AND ASH-HANDLING MACHINERY IN CONNECTION WITH MECHANICAL STOKERS.
Commerce Street Plant, Milwaukee Electric Railway and Light Co.

omy of operation. A header is an emergency member and should be used at no other times.

It is interesting to note the length of steam pipe installed in the New York Subway plant.* Figuring the present plant of ten 7,500-horse-power engines, 6,500 feet of main steam pipes are installed, about 2,000 feet of which constitute the so-called "equalizing system" similar to three headers, the purpose of which is to equalize the pressure over the entire plant. For operating this plant 1,000 feet of live steam pipes have been added for supplying the auxiliaries. This gives 0.1 ft. per normal horse-power.

To provide the steam main with a quick-closing valve is good practice. The Germans are forced by law to install self-acting cut-off valves, with which, in cases of accident in a particular main line, the steam is automatically cut off. This is often accomplished by introducing a valve containing a ball of larger diameter than that of the pipe. Under ordinary circumstances, the steam (the velocity of which is capable of regulation at the valve), travels over the ball; in case of rupture in the pipe the increased velocity raises the ball pushing it against the outlet. This of course is not a tight cut-off, but it prevents the bulk of steam from escaping. Highly satisfactory results have been obtained by the adoption of this device, and it may have saved many a life.

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* Franz Koester, The Engineer, Dec. 1, 1904.

Conveying steam through a pipe main necessitates a certain loss of heat. Experience has proven that the higher the pressure or hotter the temperature the smaller the comparative loss of heat, and therefore superheated steam is not as much affected as saturated, although nearly all tests made on superheated steam report that they were able to draw off condensed steam from the main. This, as Dr. Berner reports in *Zeitschrift des Verein Deutscher Ingenieure*, is due to the lower conductivity of superheated steam, which plays a great role in this respect.

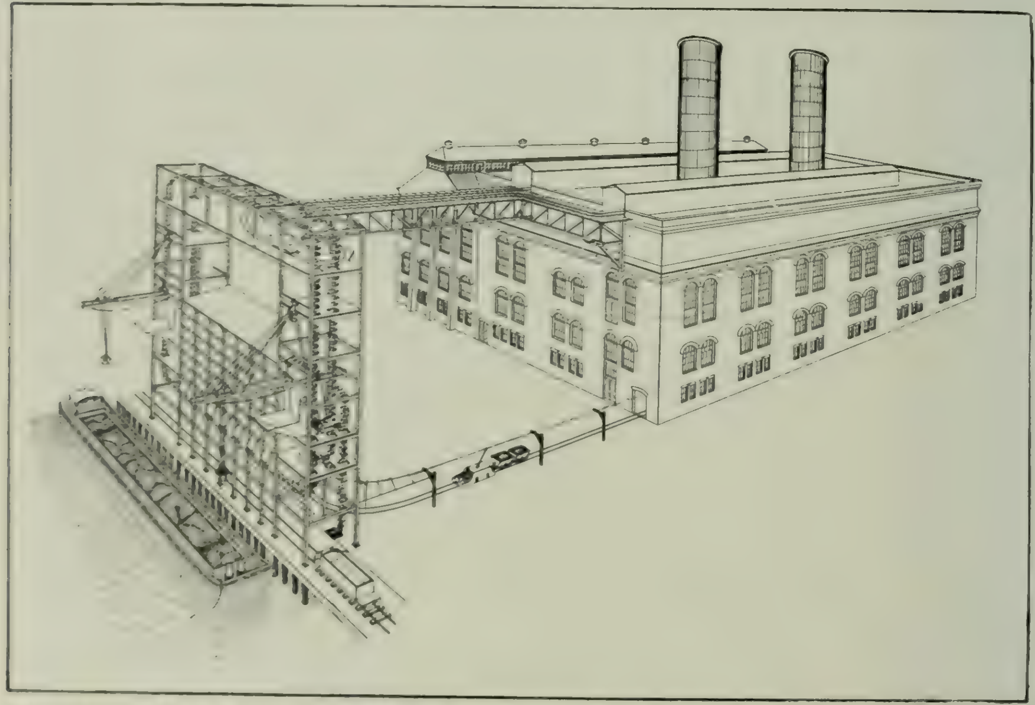

FIG. 54. COAL AND ASHES HANDLING SYSTEM, WILLIAMSBURG POWER STATION OF THE TRANSIT DEVELOPMENT CO., OF BROOKLYN.

Two unloading towers, similar to those in the Edison plants, with coal crushers, two McCaslin conveyors, cable road for distributing coal in bunkers and ash tracks with electric locomotives. Capacity, 250 tons an hour. The Mead-Morrison Mfg. Co., N. Y.

The loss of heat is dependent upon the character of the pipe, the material of the outside surface, and the temperature drop between this surface and the surrounding air. A great part of the condensation may be prevented by covering the pipe with non-conducting material. Many different substances are used for this purpose, but none of them can entirely prevent the condensation. Tests made by Professor Rietschel in connection with the high-pressure distance heating plant of Dresden show that felt and raw silk are the best insulating substances, but owing to their inflammability they are unsuitable with high degrees of temperature. He therefore suggests first plastering the pipe with "kieselguhr (an earthy substance) then applying the mentioned materials. Pasquay has obtained very satisfactory results by surrounding the pipes with air jackets. Rietschel, who also experimented with this system, suggested the dividing of these jackets into small chambers to prevent the circulation of air. The pipes of the above mentioned Dresden heating system, about one mile long, are covered with jackets of perforated sheet iron, over which a layer of raw silk is wound, all of which is enclosed in a second similar jacket. Professor Rietschel, by further experiments, also suggests the covering of the pipes with a mixture of plaster and organic material, which latter, on account of the heat, will burn out leaving small air spaces. Perhaps one of the most complete series of experiments for obtaining the value of pipe-covering materials was made by Stott[*] at the New York Elevated power plant. These tests were made preliminary to the letting of the contract for pipe-covering materials. The results of these tests prove that the saving of heat with different materials varies from 78.4 per cent. to 89.4 per cent. The latter, with a 2-inch pipe, was obtained with 2½-inch covering composed of 85 per cent. carbonate of magnesia, ½-inch blocks, about 3 inches wide by 18 inches long, next to the pipe and wired on, over which were placed solid 2-inch moulded coverings, the outside being finished with 3-ounce canvas pasted on. Berner remarks on this that these results are higher than have been obtained elsewhere with either steam or water. Care should also be taken to prevent radiation from the covering, which may be done by keeping them white or covering them with galvanized sheet-iron plates.

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[*] Convention of Association of Edison Illuminating Companies, at Mt. Washington, N. H., Sept. 9, 10, 11, 1902.

THE DOCKYARDS AND SHIP-BUILDING PLANTS OF JAPAN.

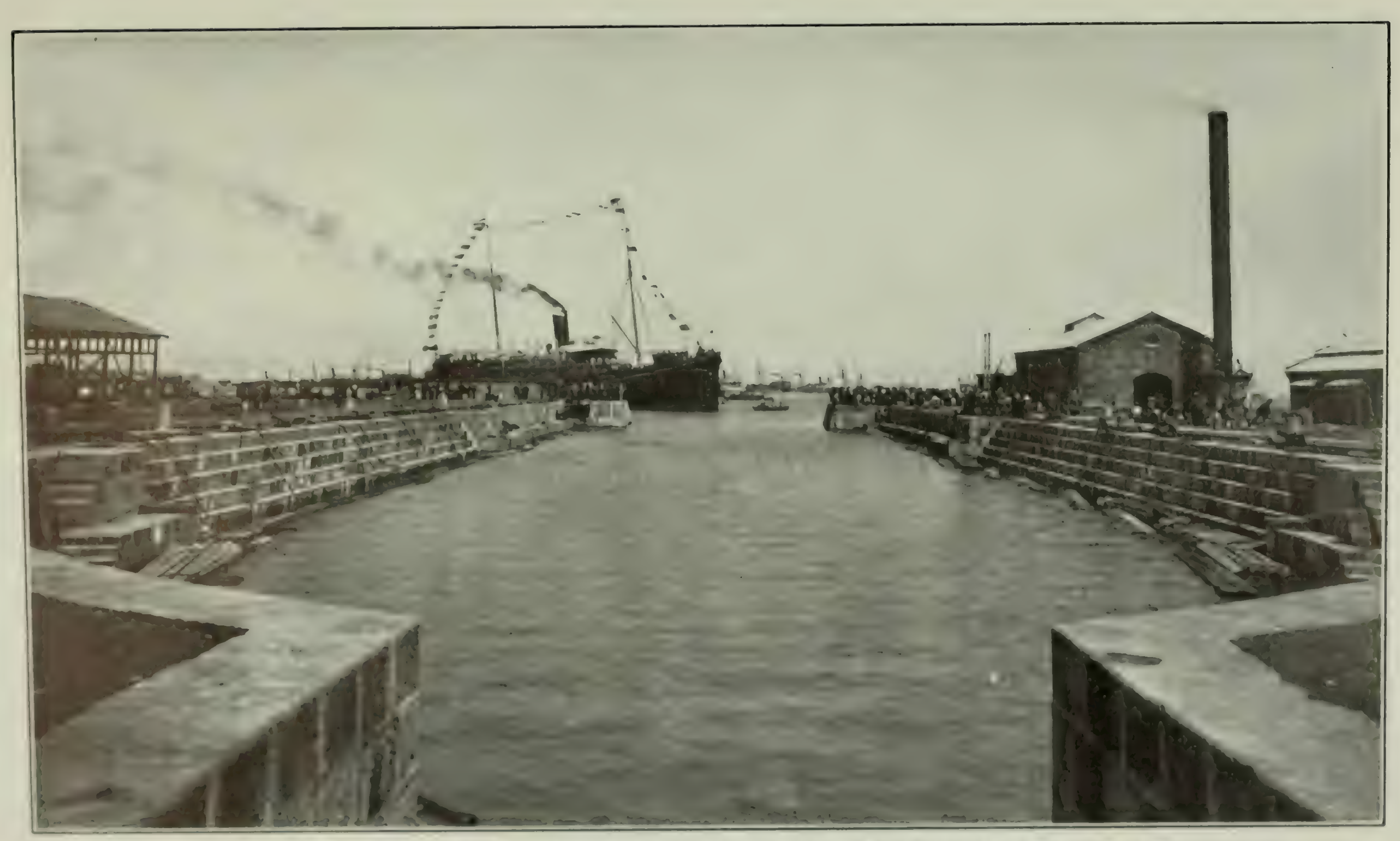
By Chas. Albertson.

Recent history has made any study of Japan's industrial resources and future a matter of keen interest. This interest appears in a new light when it is regarded in connection with the changed relation between the Orient and the Occident which will be established by the opening of the Panama Canal. Mr. Albertson's long and intimate familiarity with engineering matters in Japan enables him to present the subject with authority and discrimination. This first paper, dealing with the general conditions and the Government yards, will be followed by a second, treating more fully still and with fuller illustrations of the private ship-building yards of the Island Empire.—The Editors.

THE Japanese are quartered on a long, narrow, very mountainous group of islands having an area one-third larger than the British Isles and about equal to that of California, of which only 12 per cent is capable of cultivation. The dense population of from 45,000,000 to 50,000,000, all dependent upon the products of the field and the nearby waters, carry on their outdoor work by many an ancient method. Their struggle for existence has not been an easy one. Yet with all this they are contented and happy, for the struggle has not been characterized by the haste and intense strain under which we labor. In this respect they are wiser in their day and generation than we are.

When considering Japan's progress it is well to remember that there are at least two view-points. One is the Japanese; and if we judge by their notions, the advancement during the time occupied by the last half of Marquis Ito's public life alone is little less than marvelous. This is the point of view persistently put forward by them and oftenest seen in newspapers. On the other hand, from the outlook of a foreigner who has lived in Japan and knows the average as well as the exceptional conditions, they still have a long way to go in their industries and civilization to attain the eminence they are popularly given credit for having already reached.

Japan progresses. Her ship-building progresses also. So do her other industries. Were it possible, a hasty glance along a few other lines of Japanese industry would be of interest as showing in a general way the past and existing conditions and the present state of



VIEW OF FIRST SHIP, SAIKIOMARU, ENTERING NO. 2 DOCK, 1897. YOKOHAMA DOCK CO., LTD.

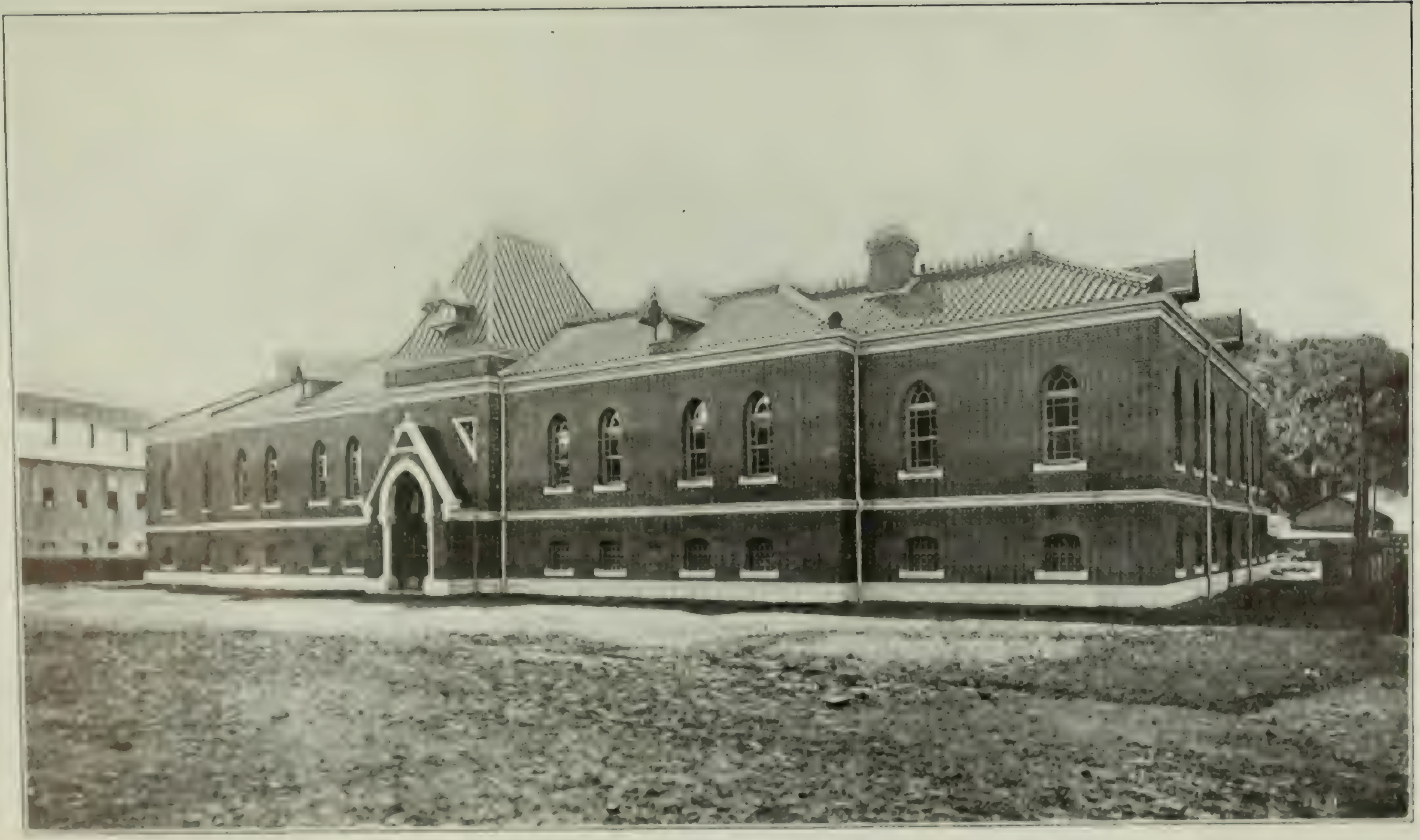
progress. This comparison of industrial works should give the relative progress and position of ship-building as compared with the improvement and present standing of other industrial enterprises. It would also emphatically evidence the fact that Japan's industrial growth has not been in ship-building alone, but that her progress has been along all lines, and therefore that ship-building has only been keeping pace with the national progress.

We may only state that in coal, copper, gold, and other mining she is using up-to-date appliances with good results. In the matter of electric street railways, her urban and interurban systems are well equipped and well paying. Her steam railroads have been extended and improved, and the rolling stock and shops are in good condition. The postal system is a credit to the nation. The telegraphs and telephones are efficiently conducted at rates about half of what we must pay in this free country. Cotton spinning and weaving mills are successfully run. Electric-light and power plants, operated some by steam and some by water, are starting up in all advantageous places. Gas plants are being built, and the large cities are already supplied with excellent water works. And so on through the whole line of enterprises there is progress and success.

Even yet, in the matter of competition, the ship-building capabilities of the Mikado's Empire are not large enough to be of intense interest or much concern to the mighty ship-building nations of the earth. However, since Japan is creating an interest in herself by rapidly forging ahead and properly taking her place in the family of nations, all that directly pertains to her growth and welfare must sooner or later interest the other nations. Moreover, because of her insular and isolated position, she herself is mightily interested in and may later be more dependent upon her ship-building interests, both industrial and as a means of defense.

National pride is a strong Japanese characteristic, and hence while there is no especial antagonism against the foreigner the Japanese earnestly desire to get all industries in their own hands and then be independent. This desire will be a long while in seeing its fulfillment, for we are none of us independent.

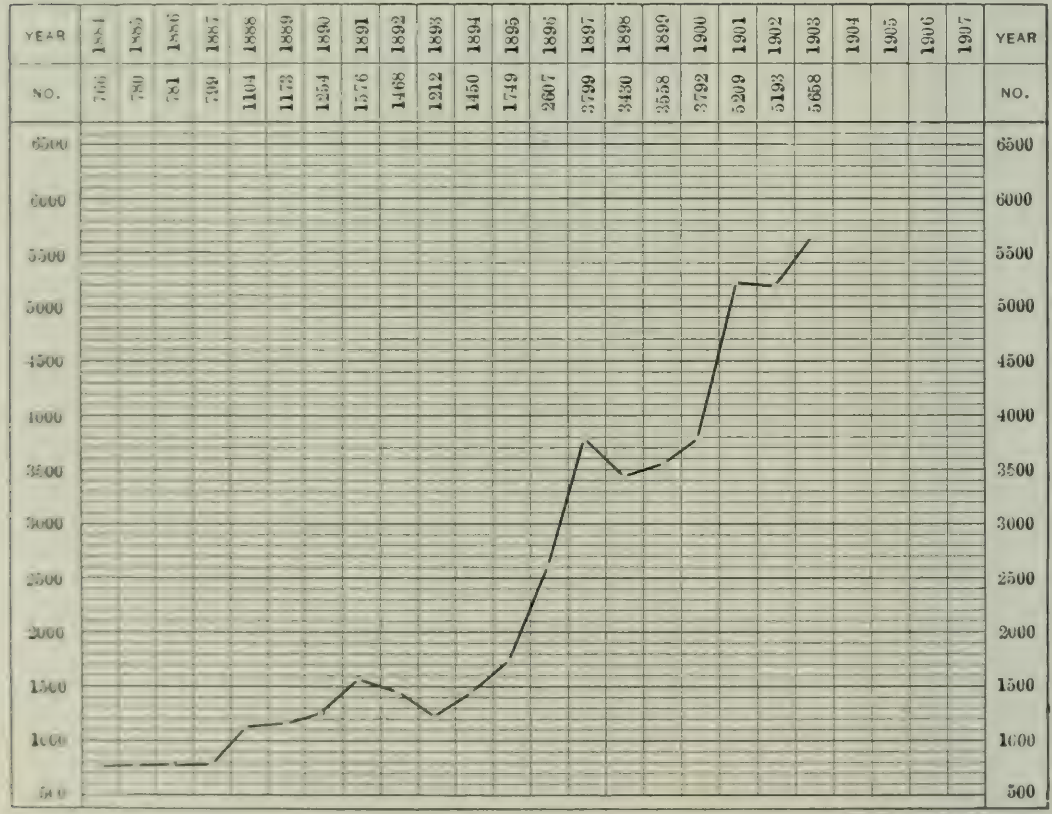
Rear Admiral Sasao, director of the Naval Construction Corps, said in an address two years ago that "It is, perhaps hardly necessary to point how important it becomes to promote other industries connected with ship-building, in order that we may drive out foreign-made goods altogether from ships built in this country." A Japanese engineering journal voices the same sentiment, a native translation



SCHOOL AT MITSU BISHI DOCKYARD AND ENGINE WORKS.

of which follows:—"It is to be extremely regret that there still imported from abroad for larger ships, but it is very joyfully for these Japanese ship-building business were incidentally improved by each every year."

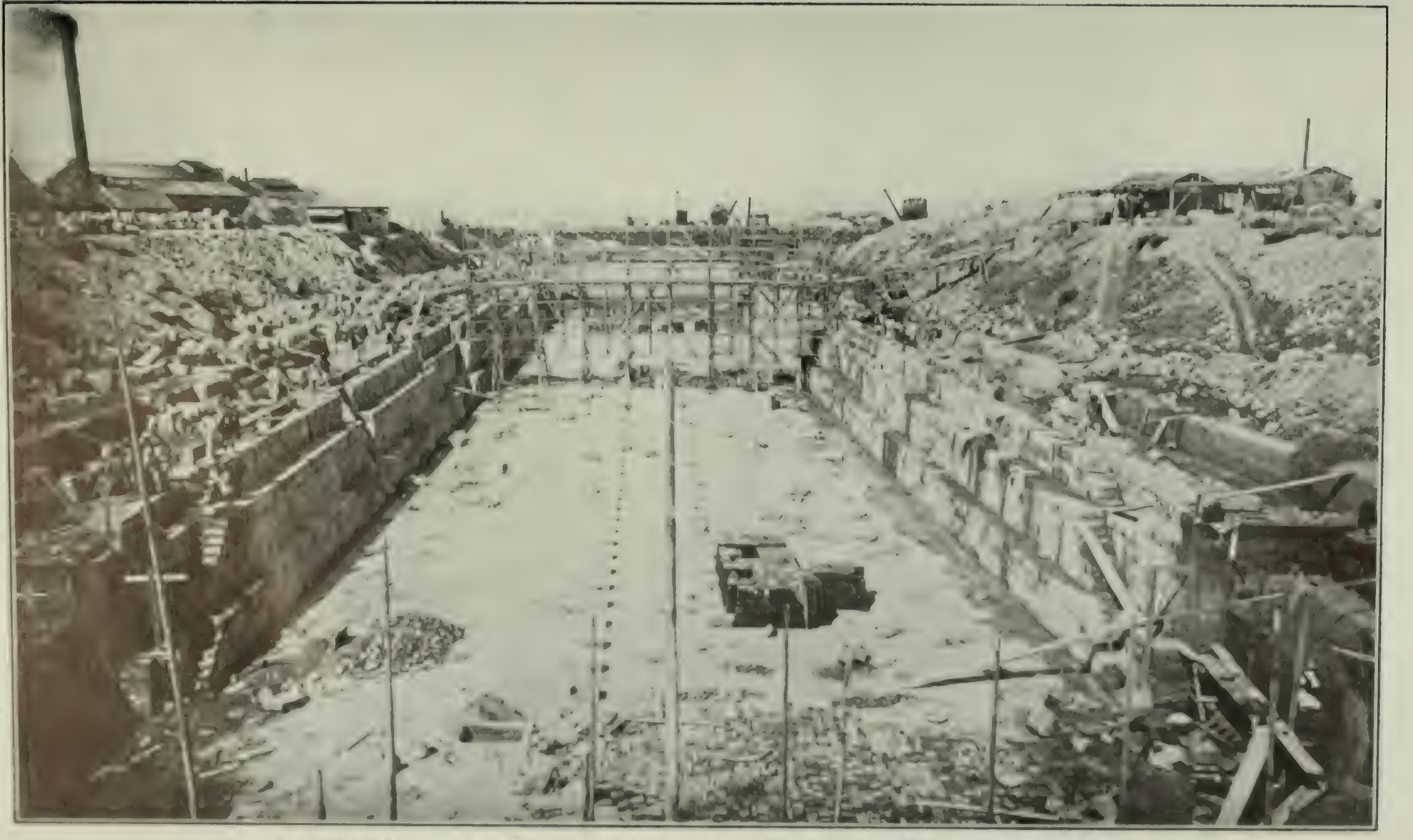
It is well to keep continually in mind the fact that Japan has done but little or nothing to add to the science of ship or engine building. Other nations have learned nothing new from her along these lines, yet this should not detract from the credit due her on account of her splendid advancement.



The Engineering Magazine

DIAGRAM ILLUSTRATING NO. OF WORKMEN EMPLOYED IN SHIPBUILDING 1884-1903 INCLUSIVE IN JAPAN. CENSUS TAKEN EACH YEAR.

Her problem is the adaptation of the present knowledge of other peoples to her own use, and the training of men to use this knowledge for her benefit. This in itself is a large undertaking, but the results show strikingly how well it has been accomplished. She did not start with the old-fashioned paddle-wheel steamer and its primitive machinery, but jumped at once from the wooden junk to single-and twin-screw steamers with compound and triple-expansion engines. She has been compelled to develop men rather than machinery. Even with the advantage of starting way up the ladder of science, she still

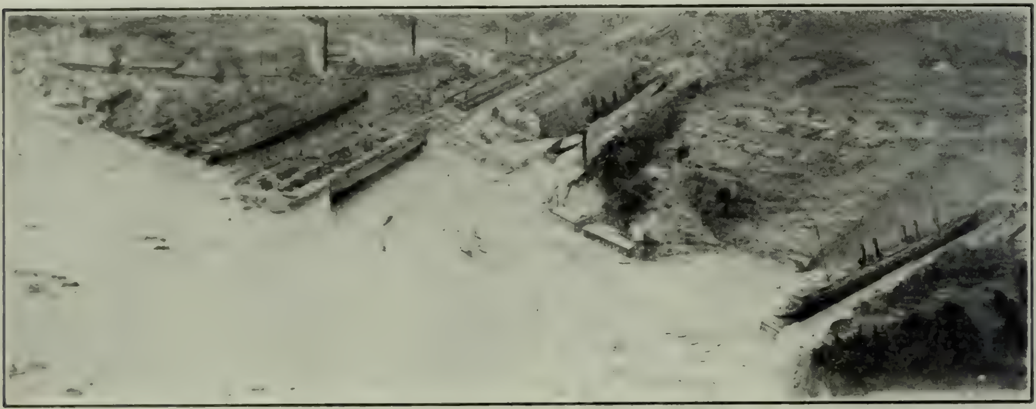


VIEW OF LARGE DOCK IN COURSE OF CONSTRUCTION. YOKOHAMA DOCK CO., LTD.

Typical Japanese dry-dock construction.

has many, many rungs to climb in order to reach the height attained by other nations. That she is climbing, and climbing well, everyone admits.

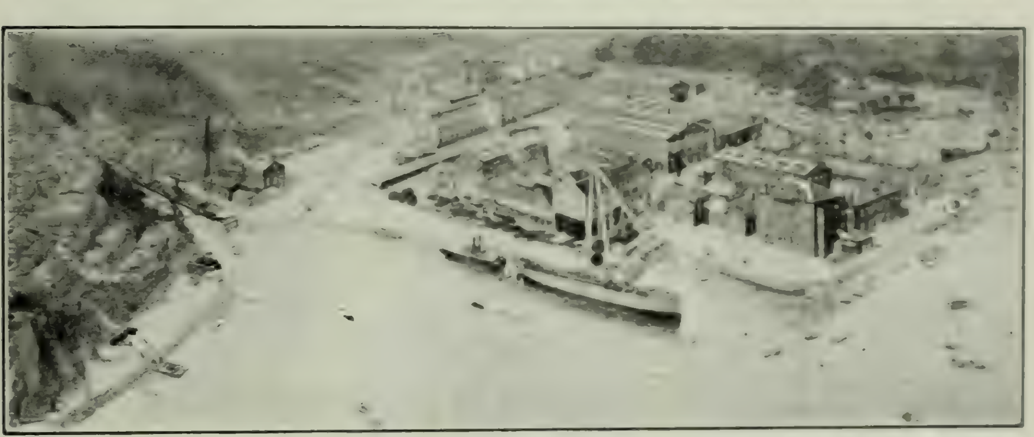
It is a curious fact, worthy of note, that Japanese thought and language contain absolutely nothing in the way of words, or parts of words that could be pieced together, to express modern shipbuilding and marine terms. They have therefore borrowed outright most of the English technical terms, and use these, although at the Mitsu Bishi works a few old Dutch words linger in use. Even on shipboard a Japanese captain gives his commands in English. All this helps to show how very new and strange ship-building and its component industries were to the Japanese.



THE MITSU BISHI DOCKYARD AND ENGINE WORKS. HALF VIEW. COMPLETED ON OPPOSITE PAGE.

If one could be dropped unawares into a modern Japanese shipyard, with eyes blindfolded and the peculiar sounds of the Japanese language kept from the ears, the sensation produced would be exactly similar to stepping into an English or American shipyard, for the clatter of pneumatic caulkers, riveters and chippers, the rattle of plates, the grinding of punching and shearing machines, the thud and jar of steam hammers, the whir of motors, the crunching of hydraulic machines, and the racket and rumble of hammers and machine tools generally all conspire to give one the same feeling of progress and activity in the various departments that would be experienced in the home land. The appliances are the same, the result is the same; but the work is being done by a different nationality—one that is strictly Oriental, but nevertheless one that is versatile enough to take up the best that all nations have to offer.

About three hundred years ago, Japan was one of the most progressive, vigorous and powerful of all the maritime and ship-building nations of the Far East. So apt were her seafaring people at designing and building the then great ships that she developed a fleet of fast three-masted junks which outsailed the ships of China, Korea, and all other Eastern nations. This superiority in the matter of speed, besides building up a great sea trade, soon produced a class of pirates who plundered everything upon the high seas. Complaint after complaint from other nations reached the ruling Shogun at Yedo. For this and other reasons an edict was finally issued forbidding the building of junks having more than one mast. From that time even to the present day, many of these picturesque though awkward, one-hundred ton junks sail the island-dotted waters of Japan. A later law giving full freedom to ship-building favors a type of foreign schooner rig, and soon the big, single, square sail will be seen no more.



VIEW OF MITSU BISHI DOCKYARD AND ENGINE WORKS. COMPLETED FROM OPPOSITE PAGE.

Under a wiser *regime*, her summarily arrested development has taken on a new start and a new form, for today she builds in steel and sails by steam. It is no news that Japan is making a mark in the great world, and to ship-builders and associated industries it will doubtless be of interest to know what may be expected of the Little Sea Realm in an industry upon which she is so dependent. England goes surely and steadily onward in the yearly construction of vast maritime fleets and great navies of peace-keepers. Germany has startled the marine world by her strides in the same direction, and lately the United States has surprised the globe with the work of her new and old shipyards, particularly as evidenced in the small though unexcelled home-built navy.

It will be the purpose of this review to show exactly and accurately what Japan has been and is doing, how well she is doing it

YOKOHAMA DOCK CO., LTD. GENERAL VIEW OF WORKS AND DOCKS.

YOKOHAMA DOCK CO., LIMITED

Barque Asterisk in No. 2 Dock, [illegible] tons [illegible]

the difficulties under which she labors industrially, and her dependence on other countries for material; then a reasonably correct forecast of the future may be made. A complete description of yards, their equipment, output, management, and labor conditions, together with a statement showing how the demand arises for repairs and ships, will therefore be pertinent and necessary to the subject.

A general survey of Japan's ships and shipping shows that in 1870 the Japanese owned about 17,000 tons. Before the war with China there were under the Japanese flag a total of 225,000 gross tons. At this time the Japanese mercantile marine carried about one-tenth of the total exports of the empire. At the end of 1903, the number of vessels above 20 tons registered in Japan was 1,088 steamers, having a gross tonnage of 657,269, and 3,514 sailing vessels, mostly junks, with a gross tonnage of 322,154; or, in all, 4,602 vessels having a gross tonnage of 979,423. These figures include foreign-built as well as Japanese-built steamers, for in order to carry the Japanese flag they must belong to the Japanese.

TWIN SCREW TUG, TOBEMARU; 100 FEET LONG, 300 I. H. P. YOKOHAMA DOCK CO., LTD.

In 1902, 23,000,000 tons of shipping entered and cleared at Japanese ports, of which more than one-third was under the Japanese flag.

For ten years ending 1903, the average tonnage of Japan's steamers increased from 180 tons to 650 tons. Since the ship-building subsidy act of 1896 there have been built in Japan about 40 steamers qualified to receive the subsidy benefits. These range in size from

713 tons to 6,444 tons, gross, making a total of, roughly, 100,000 tons, having a total of about 83,000 indicated horse power. The speeds vary from 10 to 15 1-3 knots.

In 1893 Japan built 26 steamers totalling 4,000 gross tons and bought 10 steamers totalling 13,000 gross tons. In 1903 she built 65 steamers of 33,600 gross tons, and bought 17 steamers of 33,400 gross tons. It will thus be seen that during this period there has been a decided increase in both the number and tonnage of ships built at home, while the purchase of ships as compared with those home-built is gradually decreasing.

A SMALL JAPANESE SHIPYARD, BUILDING SAMPANS AND JUNKS

The situation is typical of much of the coast of Japan.

Ship-building materials are imported from England, America and Germany principally. Contracts for delivering these articles at the shipyards are awarded, after tender, to various importing Japanese and foreign firms who buy through their home offices. The Mitsu Bishi Company, however, purchase mostly through a representative in England who buys their supplies on a small commission.

With the exception of possibly some small lathes and other minor tools for use in the little yards, Japan still imports all her ship and engine-building, dockyard, and repairing equipment. It does not take long to state this but it is worth some attention.

From pig iron to unfinished teak, from stem-post to stern-post, at least 90 per cent of the material for building ships in the Japanese

SALVAGE STEAMER OURA MARU.

Built under the Teishinsho Rules and Lloyd's special survey, class 100 AIMC. Material, Steel. Length, 186′. Breadth, 29′. Depth, 16′ 2″. Mean Draft, 11′ 6″. Gross tonnage, 712 tons. Speed, 12¼ knots. Engines, Triple expansion. Horse power, effective, 700. SALVAGE GEAR. 3 12″ Centrifugal pumps, 1 18″ Centrifgal pump, 3 Pulsometers, 1 15″ Special pump.

yards is imported. This is also worth some attention. Some of this, of course, arrives in the raw and is finished or made up at the yards; but many smaller items, such as deck machinery, pumps, fittings, etc., are imported complete. To order and deliver these supplies takes time, so that short delivery after placing a contract is impossible. All this, with labor cheap in price but not altogether efficient, shows that she is not the best favored nation in the world in regard to ship-building. Builders and owners must therefore depend on the assistance of subsidies for a long time to come.

If she had a good supply of iron ore—which she has not—there would be then some hope of changing the present unfavorable conditions. One opportunity for improvement lies in increasing the efficiency of her labor without an undue increase in wages.

Longing for industrial independence, and also to meet the home demand for plates, shapes and rails, the Government has established a steel plant in Yawatamachi, near the western entrance to the Inland Sea, capable of turning out 80,000 tons a year. The works import the nearest iron ore from China, and as Japanese coal is not "A-1" for coking purposes they cannot be operated under the most favorable conditions. At the first the output was not satisfactory, and even today the builders prefer, for quality, an imported plate with Lloyd's test to one made in the only home works.

In 1893 there were in Japan about sixty ship-building yards. In

1903 this number had increased to one hundred and eighty-five. It must be borne in mind, however, that every place capable of building an ordinary junk is included in this number, and that the ship-building yards which are really of moment to the foreigner can be counted on the fingers of one hand.

Descriptions, some general and some in detail, will be given of enough of the private ship-building and dry-dock establishments to show the general character of all of them. Those of most interest include the Mitsu Bishi Dockyard and Engine Works, Nagasaki; the Kawasaki Dockyard Co., Ltd., Kobe; the Yokohama Dock Co., Ltd., Yokohama; the Ishikawajima Ship-Building and Engineering Co., Ltd., Tokyo and Uraga; Osaka Iron Works, Osaka; Hakodate Dry Dock Co., Hakodate, Hokkido; the Bingo Dry Dock Co., Province of Bingo; the Innoshima Dockyard Co., Province of Bingo.

Other than the largest companies mentioned above, there are five which own docks more than 250 feet in length, and three owning docks more than 200 feet in length.

Government Ship and Dockyards. Of the Imperial Government Naval Dockyards only a few bare facts dare, with propriety, be given. These yards are four in number.

One is at Yokosuka, nicely inside the entrance of Tokyo Bay, and has three good dry-docks. Here can be easily docked the largest battleship afloat. Among the war vessels constructed here may be mentioned the four largest, namely, the "Hashidate," an unarmored cruiser, 301 feet by 51 feet by 20 feet, of 4,200-tons displacement, a designed horse power of 5,300, and a speed of 16 knots, which was launched in 1891; the "Akitsushima," an unarmored cruiser, 300 feet by 43 feet by 17 feet 6 inches, of 3,100-tons displacement, a designed horse power of 8,400, and a speed of 19 knots, was launched in 1892; the "Niitaka," a third-class unarmored cruiser, 335 feet by 44 feet by 76 feet, of 3,366-tons displacement, a designed horse power of 9,400, and a speed of 20 knots, was launched in 1902; the "Otawa," a third-class unarmored cruiser, 321 feet 6 inches by 41 feet 3 inches by 15 feet 9 inches, of 3,000-tons displacement, a designed horse power of 10,000 and a speed of 21 knots, was launched in November, 1903.

Leaving out torpedo-boats and torpedo-boat destroyers, these vessels constitute half the total tonnage of warships turned out in all Japan, and comprise two thirds of Yokosuka's tonnage. They are also the largest ever built by the Government in the Island Empire. This shows clearly how small a part of the Imperial Japanese Navy is home-built, since official records show that Japan has between 15 and 50 war-vessels of over 1,000-tons displacement, approximating in all 250,000 tons.

Another of the Naval yards is at Kure, hidden safely away among the islands on the north shore of the Inland Sea. Here are two dry-docks and here was docked the American battleship "Oregon" when the Russians claimed that the Port Arthur dock was too small.

The "Tsushima," a third-class unarmored cruiser, 334 feet 9 inches by 44 feet by 16 feet 3 inches, of 3,400-tons displacement, a designed horse power of 9,400, and a speed of 20 knots, was launched here in 1903. The recent exhibition in Osaka had on view a 10-inch gun made at Kure, as well as a full line of smaller arms and a very complete set of steel castings. These were the work of the Arsenal Department. Armor plate has not as yet been manufactured in Japan, but appropriations have been made for a complete armor-plate plant to be installed in the Kure yards.

Sasebo is another, though considerably smaller, naval yard, located at the end of a long, narrow bay on the southwestern coast of Japan. Here they have one large dry-dock.

Maizuru is the newest of the yards, and is situated on the northern or Japan Sea side of the Empire. Here, too, they have a splendid dock.

All of these yards are so located and fortified that it would be almost impossible for a foreign navy to get anywhere within range of them. The Japanese, to a greater or less degree, build torpedo-boats and destroyers, of which they have added many to the navy.

The preparedness and excellent condition of His Imperial Japanese Majesty's Navy in its recent battles prove conclusively that these yards are well equipped and mighty efficient. A following article will give a comprehensive idea of the private ship-building plants, concerning the plans and equipment of which fuller details may be presented than is possible in the case of the Government installations.

* * *

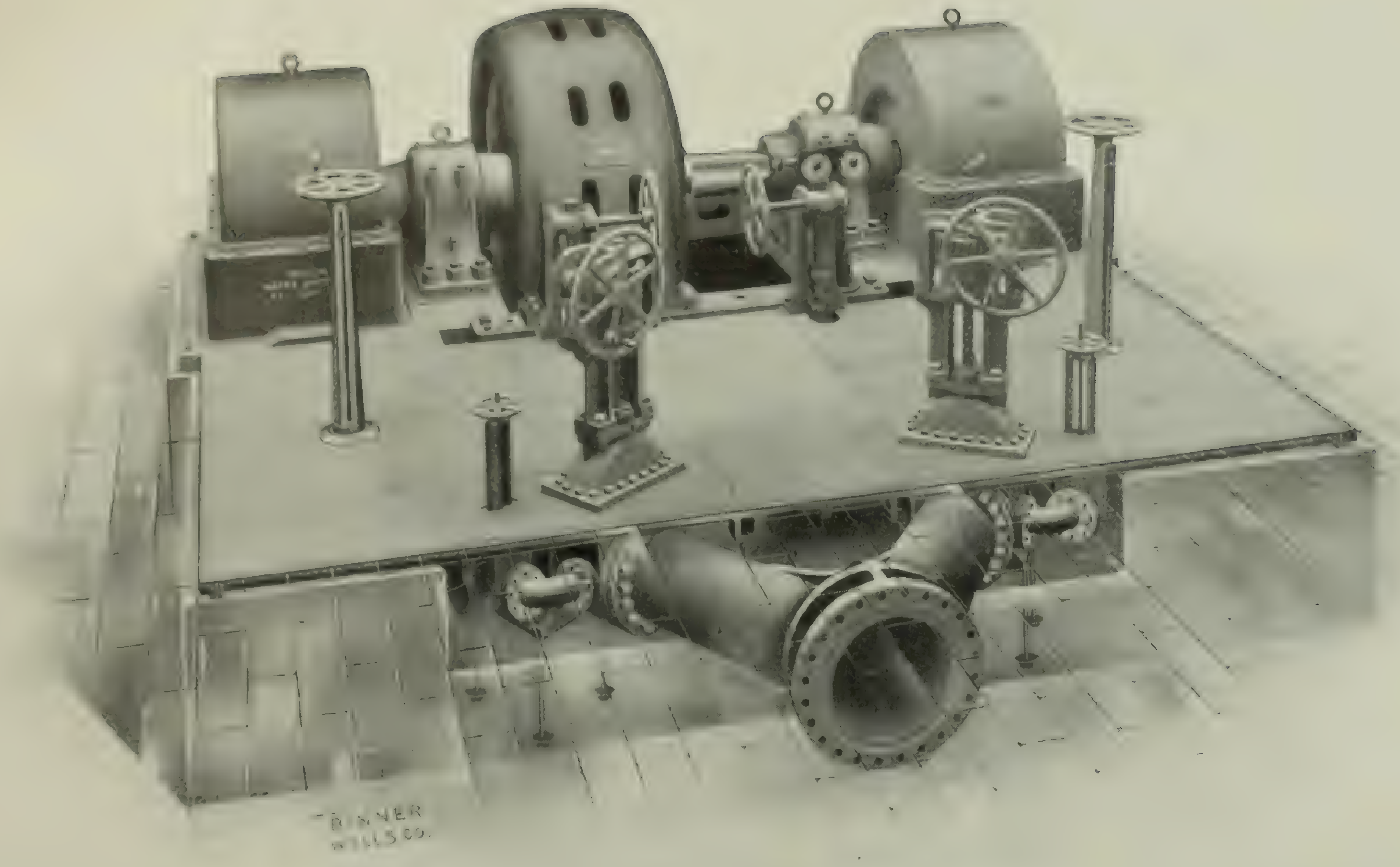
HYDRAULIC GENERATION AND APPLICATION OF MOTIVE POWER—WATER POWER INSTALLATION.

By William M. Barr

WATER power installations for generating light, heat and motive power are competing sharply with steam engines in large plants, and also with gas engines in medium and smaller installations; but a water power development to be successful as a commercial enterprise must have certain possibilities. There must be a market for the power; the cost of the power must be no greater and should be less than could be furnished by steam; the water supply must be constant throughout the year.

The minimum flow of creeks and rivers is not the same throughout the country. Some rivers have their lowest flow in the winter, others in mid-summer. The water powers of New England have been well exploited, and the peculiarities of flow are well under control. The Southern Appalachian region, is represented as having water-power opportunities which, when developed, will exceed in value the more important coal fields which they contain. The French Broad River, draining a thousand square miles of territory, which falls [illegible] feet in its course, never rising more than seven or eight feet during the worst floods, is an example.

The size of any proposed hydraulic power plant will depend upon the use to which it is to be put. If the power is to be applied where generated, as in the case of a mill located alongside a stream furnishing the supply, a size of wheel will be selected to furnish the power necessary for a fixed output of merchandise which may utilize but a small portion of the available energy, and no special care need be exercised as to the minimum volume of water during the dry season, provided the stream does not then become wholly dry. If the demand for power be such that all the available energy can be utilized, then a careful survey of the water shed must be made. A preliminary sur-

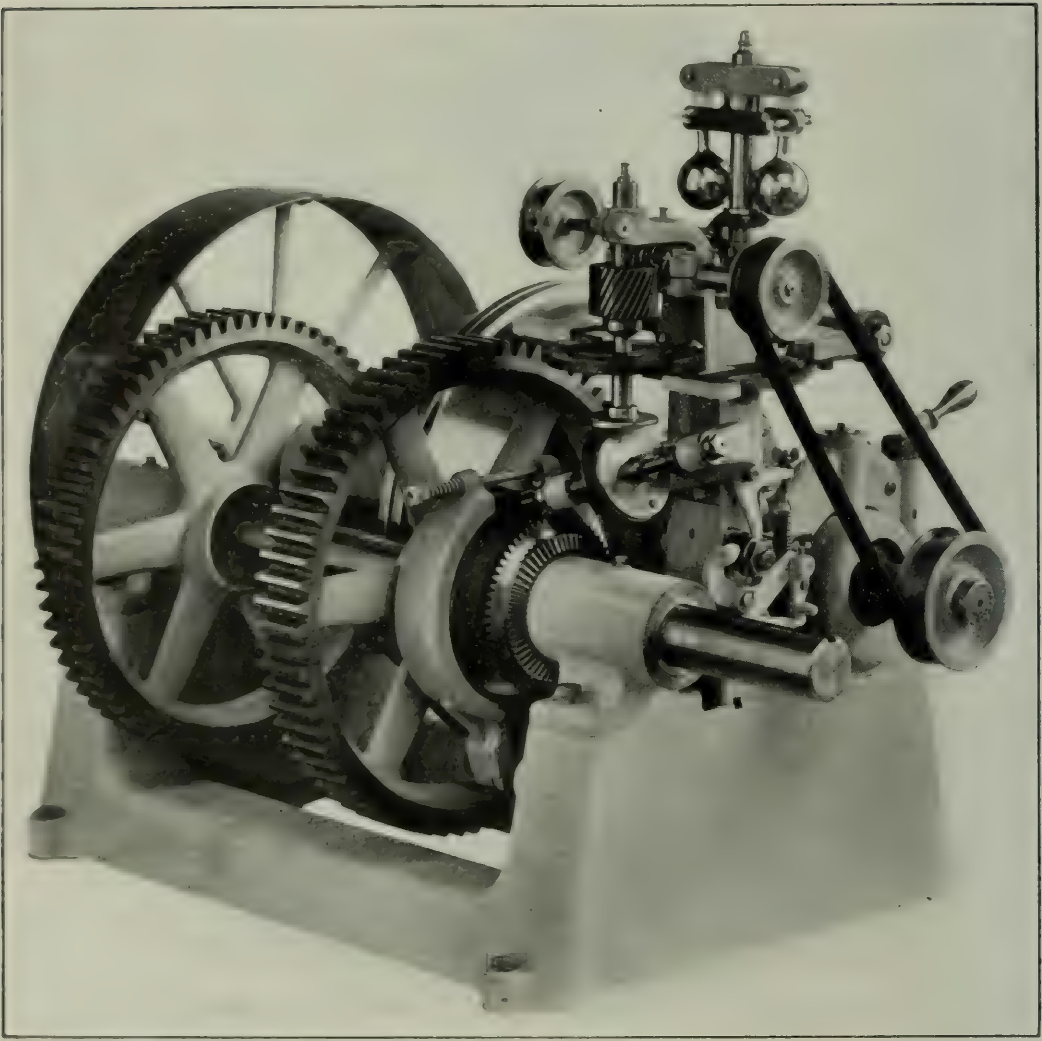


PELTON WATER WHEEL.

vey should extend throughout a year, carefully recording the measurements relating to volume of water available during the dry season. Drainage area and average waterfall are not sufficient data; the actual minimum flow during the dry season determines the safe size of power plant for every day service throughout the year. Any drainage area having extreme low water during the dry season is certain to have periods of excessively high water following the winter months and the rainy seasons of the summer months. A stoppage of a water power plant by reason of flooding may be fatal to the commercial side of the undertaking, even though the stoppage occur but a day or two at a time, and for but two or three times in a year. This would be analogous to the stopping of a street railway system, or the extinction of electric lights in a City for three or four days. It would so depreciate the value of the securities based upon such a plant as to make investment undesirable except at a ruinous discount from face values. In such a case there is no other alternative than to duplicate the plant with either steam or gas engines which, remaining idle throughout the greater part of the year, would result in financial loss; so that from a competitive standpoint, any proposed water power, among other advantages over steam power, must have the assurance of constant supply. The problem finally resolves itself into Water vs. Coal.

Reciprocating steam engines of the best design and construction will, at 160 pounds pressure, in large units, develop an indicated horsepower per hour for each fifteen pounds of water evaporated, the steam being delivered to the engine at not less than 160 pounds pressure. It is admitted that lower figures have been published by competent experts—Thurston, Barrus, Dean and others. The lowest record up to the year 1900 was 12.5 pounds of steam per I.H.P. per hour with a boiler pressure of 155 pounds and without superheating. But the highest efficiency reached in this country is that of the triple expansion pumping engine at Chestnut Hill, Boston, with a record breaking performance of 10.335 pounds and a thermal efficiency of 21.69 per cent. Professor Ewing in *Engineer, London*, states that in a certain test made by him, the consumption of steam was just 9 pounds per I.H.P. when the engine was working at the most favorable load. The steam pressure was 140 pounds, with 800 degrees superheat. No such record has been made in this country. For our present purpose 15 pounds may be considered to be good practice in steam engineering for the best types of reciprocating engines.

Steam turbines, in this country at least, have shown no thermal advantage over the best types of reciprocating engines, the Parsons



HORIZONTAL MODEL COMPENSATING TYPE GOVERNOR. THE WOODWARD GOVERNOR CO., ROCKFORD, ILL., U. S. A.

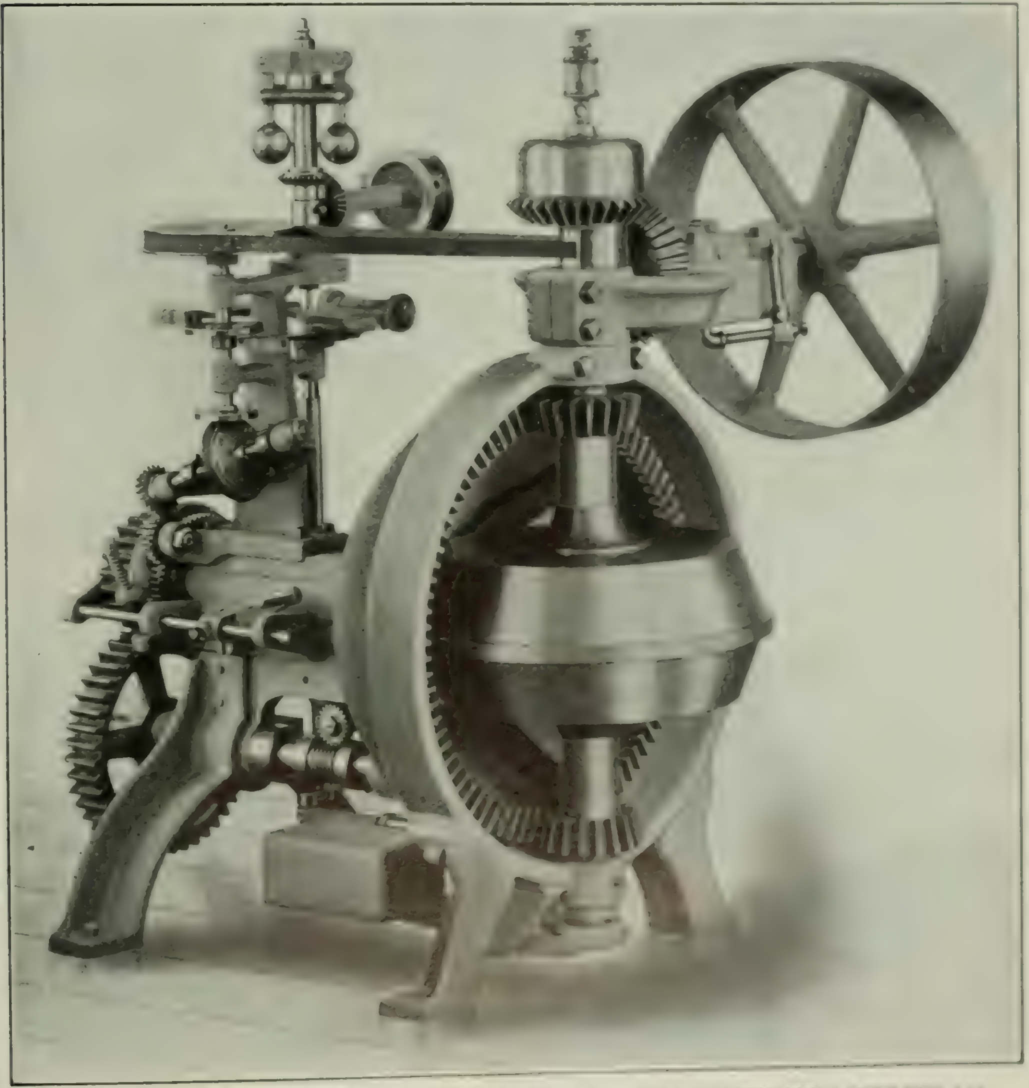
Type E. is adapted to units up to 3,000 h. p.; type F. up to 1,200 h. p. Among the numerous important installations of this governor, is that at tne U. S. Arsenal, Rock Island, Ill. The capacity of a governor is principally limited by the power required to operate the gates.

De Laval and Curtis turbines averaging about 15 pounds of steam per I.H.P. per hour.

A large annual rainfall together with an enormous drainage area throughout the United States has made possible the profitable development of thousands of water power plants. The possibilities of electrical transmission of energy has transformed many a mountain stream hitherto of no commercial value into a source of profit.

A cubic foot of water weighs about 62.36 pounds; the horse power for any given volume and head would approximate cubic feet of water flow per second x 62.36 x head of water in feet -:- 550. There will, in practise, be an aggregate loss from various causes of from 20 to 40 per cent. of the total, say 25 per cent., by way of average.

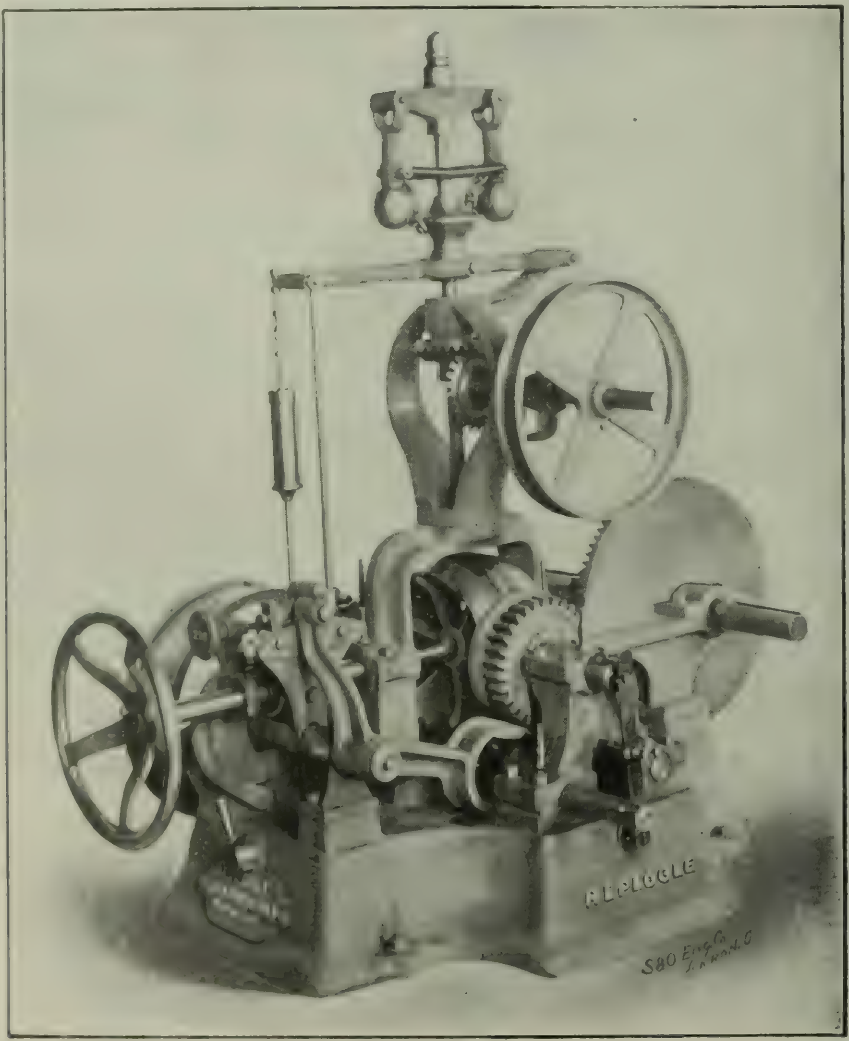
The selection of a water wheel resolves itself practically to choice between a turbine, if for low or medium heads, and an impulse wheel for high heads. Ordinary turbines work well under moderate heads, say 10 to 20 feet. The next thing is to design the head and tail races. If the wheel is to be supplied by an open canal or headrace, the latter must have an area of cross section such that the flow of water to the wheel shall not exceed 60 feet per minute for a long headrace, increasing to 120 feet per minute for a short one. If the headrace is insufficient in area of cross section in proportion to its length, there will



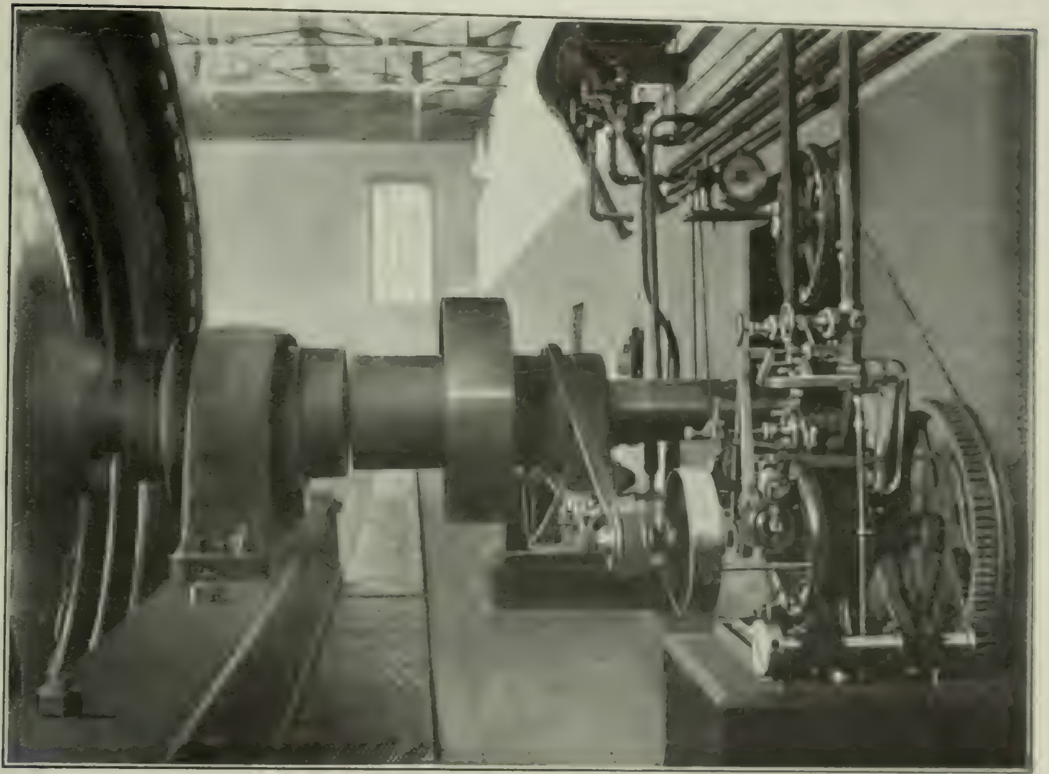
VERTICAL MODEL COMPENSATING TYPE GOVERNOR. THE WOODWARD GOVERNOR CO., ROCKFORD, ILL.

Type C. is used mostly on wheels up to 600 h. p.; type D, up to 900 h. p. A large number of these governors are installed in the U. S. and in Europe.

be a gradual loss of head which results in loss of power. The tail-race should have an area of cross section such that no greater velocity of flow than 100 feet per minute will occur; and there should be not less than two feet of dead water at the point of discharge for small wheels. This depth may, with advantage, be increased to four or five feet in the case of large wheels. Such depth of water occasions no loss; the water discharged from the wheel displaces the dead water with practically slight loss of head. The rule that for any diameter of wheel under any head, there should be one square foot of cross sectional area of head-race and of tail-race for every 120 cubic feet of water used per minute, should be rigidly observed, as when the head is reduced from any cause, there may still be sufficient flow to run the wheel up to speed and capacity.



REPLOGLE GOVERNOR NO. 3.
Designed for large turbines or multiple units of medium sized turbines. 7,500 foot-pounds capacity. Replogle Governor Works, Akron, Ohio, U. S. A.



WATER WHEEL GOVERNOR.

Sturgess Governor Engineering Company, Watervliet, N. Y., U. S. A.

When the water is conveyed to the wheel casing by a metal pipe, the receiving end should be well submerged to prevent the inlet water from drawing in air, and lessening the efficiency of the wheel. An increased velocity of flow is permissible, which should not, however, exceed 180 feet per minute for pipes up to 150 feet in length, reducing the velocity to 100 feet per minute in pipes 250 feet long. No loss of head is likely to occur at these velocities in a pipe free from sharp angles.

Draft tubes can be used in connection with turbine wheels in favorable locations; such tubes should extend vertically downward and should not greatly exceed 20 feet in length. They should in all cases be made of plate metal, strongly riveted and caulked air tight. One of the writer's earlier experiences was with a 48-inch draft tube extending down a slope about 300 feet in length, the fall being about 23 feet; it was simply impossible to maintain a constant speed of wheel until an air pump was set in the wheel house, by which the draft tube was kept free from air, and even then the speed and power were not wholly satisfactory.

Loss of head occurs in conveying water through pipes, thus: for each 100 feet in length, of a pipe, say, 48 inches in diameter, the water flowing at velocity of 2 feet per second, the loss in head would be 0.024 foot; at 4 feet per second, 0.093 foot; at 6 feet per second, 0.204 foot. In a 24 inch pipe increased resistance would cause nearly three times as much loss in head.

A sudden interruption of flow to a wheel is always to be guarded against, especially in the case of a closed penstock or a long pipe leading to the wheel casing. To remedy this, a stand-pipe may be used from the top of the penstock for heads under 50 feet, or a relief valve for similar or greater heads.

Combined steam and hydraulic power plants are to be occasionally found. A good installation is that at Richmond, Va., the total available fall being twenty-five feet. Double turbines of the horizontal type are situated in submerged chambers beneath the boiler room, and from the wheels concrete draft tubes extend to the tail race below. There is a complete steam auxiliary. Each turbine shaft couples at one end directly to the generator shaft; at the other end of the generator shaft is the engine crank. When it is desired to shift from water power to steam, the turbine coupling has its bolts removed, the connecting rod is attached to the crank pin and the generating plant is ready for use. It is the intention to have eleven water turbine and steam engine units of 1,000 H. P. each, upon the completion of the plant.

Turbines receive and discharge water uniformly, and usually in each bucket simultaneously. The buckets are usually curved, and the water is guided by adjustable plates into the buckets of the revolving wheel. The delivery of water to the wheel is controlled by a series of swinging valves, which may be adjusted by hand or placed under the control of a governor. The wheel is driven partly by the weight of the descending water and partly by the impulse of the flow, hence turbines may be classed as pressure or reaction turbines, or as impulse turbines. In pressure or reaction turbines, the wheel passages are filled, the energy is largely due to pressure, and the discharge is below tail water, or in a draft tube. In turbines of this class, the flow of water may be parallel or axial as in the Jonval; outward as in the Fourneyron; inward as in the Swain, Thomson and others: mixed, i. e., inward and parallel, as in the Schiele.

The Jonval turbine is a pressure turbine, consisting of a series of guide blades arranged in a ring directly above the buckets of the revolving wheel; the flow of water is downward and parallel to the axis of the wheel. This form of turbine is always drowned, or connected to a draft tube surrounding the wheel, thereby adding the suction head of the discharge to the head above the wheel. The tube should not exceed 25 feet in height. Regulation, formerly effected by throttling, is now preferably obtained by closing a number of guide passages, preserving free admission for those uncovered. The Bodine-Jonval turbine is of this class. The wheel is adjustable to the case so as to prevent loss of water by leakage. This wheel runs steadily and evenly, and reasonably free from leakage. The maximum efficiency, from tests made at Lowell, was, with full gate, 75.9 per cent; three-fourths gate, 72 per cent; with half gate, 61.3 per cent.

The Girard Turbine provides against the loss of efficiency which always occurs when pressure turbines work with fractional supply, this fault being due to the attempted driving with a pressure for which they were not designed. Girard widened his wheel passages towards the outlet, and ventilated them so as never to entirely fill them with water. The energy is purely due to velocity, and the turbine is an impulse machine; it has also a parallel flow and complete admission to whatever guide passages are open.

Outward flow turbines.—The Fourneyron turbine receives water near the axis and delivers it outward at all points of the circumference, into buckets or curved blades of the wheel, which change the flow to a radial direction, the water leaving with little absolute tangential velocity. When the supply of water is insufficient for full power, the openings in the central chamber are partially closed by a cylindrical valve which is lowered as may be required, reducing the efficiency of the wheel which, at best, ranges between 70 and 80 per cent.

The Boyden Turbine is constructed on the same principle, but differs in important particulars. The water is conducted to the wheel through a vertical truncated cone concentric with the shaft, the descending water gradually acquiring velocity with a spiral movement in the direction of motion of the wheel. The guide plates at the base are inclined to meet tangentially the approaching water. A "diffuse" or annular chamber surrounds the wheel, into which the water is discharged. The efficiency is about that of the Fourneyron.

Inward flow Turbines.—The Swain wheel was probably the first of this type. These wheels are surrounded by annular cases in which guide passages direct the water inward to the buckets. Mr Swain introduced a double curve in the form of the inwardly discharging bucket, so that the discharge is downward instead of inward; the long double curve of the bucket retains the water until it has received a very large percentage of its initial power. For a bronze wheel having twenty-five buckets, the gate had twenty-four guides set to form an angle of fourteen degrees, with the tangent to the wheel passing through their inner edges. According to tests made at Lowell, the efficiency, from about two-thirds to full gate, varied from 83 to 84 per cent.

Following the type of Swain turbine came a number of well known wheels, as the Risdon, The American, Alcott, Leffel and others.

Thomson's turbine receives its water supply at the outer rim of the wheel, the water escaping axially from the center of the wheel into the tail-race. Its energy is largely due to pressure, the outlet being either drowned or connected with a draft tube. The guide blades are pivoted and so curved that the water supply can be regulated without materially affecting the angle of the blades or other conditions. A maximum efficiency of about 75% is obtained for all openings.

Turbines attached to vertical shafts are more used than those of the horizontal pattern. Vertical turbines as ordinarily constructed and operating under heads of 25 feet and over are likely to be troublesome on account of difficulty in properly lubricating the step bearing and in replacing a worn out one. This bearing has to take the weight of the upright shaft and gearing in addition to its own weight, and in many cases, an added pressure due to the impact of the water upon the blades. To relieve the step of this weight, a water cushion operating with little or no friction has been satisfactorily employed as in the Trump turbine. The upward pressure of the water is augmented by the lessened pressure occasioned by a pipe connection leading from the chamber above the running balance plate, downward and into the inlet to the central runner. Hard wood bearings prevent metal contact between the balance plate and the stationary portions of the frame. For low heads about three-fourths of the weight is thus relieved; for high heads, the whole weight can be carried without the use of a step bearing. Direct connected generators placed at the top of a vertical turbine shaft are in use in this country, notably at Niagara Falls, as well as on the continent of Europe. This arrangement has been found to be cheap and efficient. The Niagara Falls Power Company, among other turbines, adopted a design of the Francis Turbine by Escher Wyss & Co., Zurich, wherein the balancing disc for the turbine (5.25 feet diameter) weighs 4,000 pounds; the revolving armature, weighing 69 tons additional, was 4.9 feet diameter; the upward pressure being so regulated that only about 5 tons of the total weight is carried by an outside bearing.

Vertical turbine shafts may be connected by bevel gearing to a horizontal shaft, a method commonly applied to installations having abundance of water with comparatively low head. The loss in power transmission by the use of bevel wheels will approximate 10 to 20 per cent. of the total power of the turbine.

Tandem wheels are not in common use, but such an application is well illustrated in the installation at Geneva, where the engineers found themselves confronted with a difficult problem, because of the great difference in height of water at various seasons, the variation being from 14 feet to 29 feet. As the turbine shafts were vertical with generator directly above, and a constant speed of rotation was imperative, the problem was solved by building a two story water station, and placing two turbines, one above the other below, on each generator shaft. The plant had 18 sets of turbines, 15 of which were of 1,000 horse power each.

Horizontal turbines are in very general use, and, while less efficient than vertical, bevel gearing with attendant loss by friction is avoided, to say nothing of costly repairs. They occupy more floor space than vertical ones and their first cost is greater. The elbow or other conduit for carrying the water from the wheel to the tailrace should be slightly larger than a straight draft tube under a vertical wheel. In mill practice, power transmission from a turbine is usually to a horizontal shaft. With a horizontal turbine the coupling may be directly at the end of the wheel shaft and transmission secured by an extended shaft, by belt or rope transmission from pulley, or coupling direct to a generator. Two horizontal turbines are commonly arranged on the same shaft, and connected in multiples of two, three or more pairs, each wheel commonly having its own draft tube, the water inlet being in a casing common to two wheels, the discharge being into a quarter turn elbow at each end of the horizontal casing or flume. The end thrust of the wheels is thus equalized and the pressure equally distributed throughout the flume. For single horizontal wheels, a water cushion may be employed as in vertical installations.

High speed turbines are had by reducing the diameter of the wheel. Turbines of the same diameter run at practically the same speed. The speed of rotation cannot be increased by merely changing the curve of bucket without a loss of efficiency; to overcome this loss turbines may be placed in tandem, but this is not recommended for regular service.

Impulse wheels are best suited to high heads, 200 feet and over. In turbines of this type the wheel passages are never filled, the energy being entirely due to the velocity of the discharged water from the nozzle directed against a series of buckets arranged at regular intervals on the periphery of a metal disc. The energy of the stream is absorbed by the buckets and transmitted to the shaft, the spent water falling from the buckets at no working velocity. The end of the pipe leading water to the wheel is fitted with a nozzle in the end of which is a cylindrical tip of a diameter proportioned to the head of water and the power to be developed by the wheel. The power of a wheel of this type does not depend upon its diameter, but upon the head and quantity of water discharging into the buckets. The speed of the wheel for a given head is determined by its diameter, and this speed should be constant irrespective of the power to be developed. An increase of power for a given speed of rotation can be had in the case of a small wheel by the addition of another set of buckets on the same disc with another nozzle; the power and also the quantity of water used can thus be doubled. A wheel of sufficient diameter may have two nozzles arranged to discharge into one set of buckets, the nozzles being so located that the spent water from the first discharge will not interfere with the second. Double buckets and twin nozzles are also used for the same end.

Tangential or impulse water wheels require no wheel casings, no regulating gates or vanes and no draft tubes. The conditions under which such wheels usually work require the transmission of water through long pipe lines terminating in high pressures. A satisfactory, but not unusual, installation, is the American River Electric Company's plant in Central California which has two pressure pipes 1,614 feet long and 36 inches diameter. The upper portion, which is made of red wood staves, passes over one easy grade for a distance of 400 feet, at which point the pressure is about 60 pounds per square inch. Connecting at this point is a riveted sheet steel pipe, the thickness increasing with the head; the first 400 feet is of No. 10 steel, then 150 feet of 3-16 inch, 150 feet of ¼ inch, 150 feet of ⅜ inch and 364 feet of 7-16 inch, making a total of 1,214 feet of steel pipe, a static head of 575 feet being obtained. The water wheels are constructed of cast steel plates fitted with Pelton buckets. The two impulse wheels have a maximum capacity of 3,000 horse power each. The generating plant is located about 90 miles east of Sacramento, supplying power over an 80 mile circuit to Stockton, and over a 30 mile line to Folsom, the present voltage being 35,000, but the line is built to carry 60,000 volts. A remarkable installation utilizing a head of 2,150 feet, equivalent to 935 pounds per square inch, is that of the Pike's Peak Hydro-Electric Co. of Colorado Springs, Col. There are three impulse wheels, each connected to a 750 kilowatt electric generator running at 450 revolutions per minute.

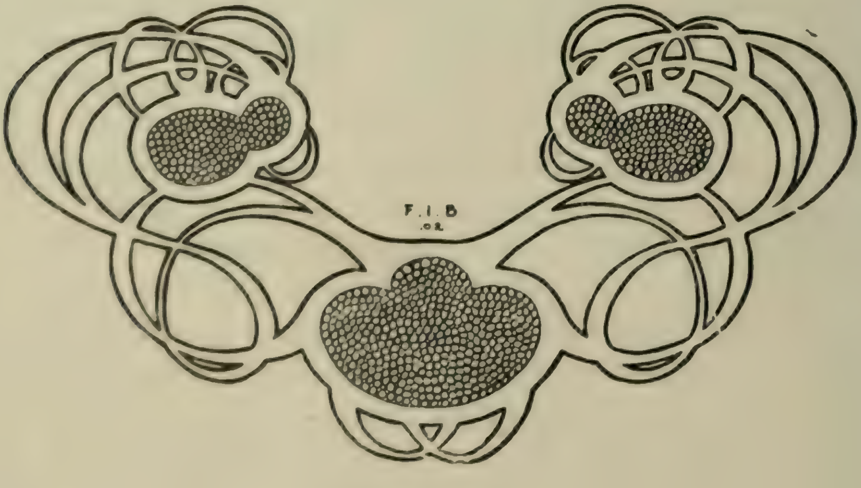
Water wheel governors are constructed with revolving weights hung on pivoted joints similar to steam engine shaft governors. At normal speed the weights are midway in the two extremes of innermost and outermost positions. Should a change of load occur the speed of the wheel will be lessened, occasioning a change in the rate of revolution of the governor; the weights will approach the center and, through proper connections, admit more water to the wheel, thereby increasing its speed, which is likely to go above the normal. The effect of this will be to cause the weights to fly further from the center, and this movement will affect a closing of the water gate and a lowering of the speed of the wheel. If this variation can be kept within 2 per cent. it is considered good governing.

The power required to operate a turbine gate is more or less uncertain, the wheel often being designed with reference to high efficiency, leaving the matter of adjustment and automatic regulation for after consideration. Through the coöperation of turbine and governor manufacturers, controlling devices are now applied by which turbines are run with a precision equal to that of steam engines. The power required to move the water gate in time to keep speed within allowable limits of variation must be supplied through the governor itself, and, in selecting a governor, this detail must have proper attention. The time limit from full open to shut will vary from 10 to 30 seconds for loads varying as much as 25 per cent. of the normal. Surplus capacity of wheel is essential to good governing. Wheels should always have an overload capacity of at least 25 per cent.

In the case of a Pelton wheel, speed is controlled by means of a cast iron deflecting nozzle provided with a ball and socket joint, permitting of its being raised or lowered, thus throwing the stream on or off the buckets. The power of the wheel is consequently increased or diminished to adapt to change of load, and a constant speed is maintained. The stream cut-off is a spherical plate fitting tightly over the end of the nozzle tip which, by varying its position, changes the discharge area of the nozzle, and thus influences the power of the wheel. The needle and deflecting nozzle is a most valuable combination. This accomplishes a two-fold object—accurate regulation and water economy without water ram. The deflecting nozzle in itself is a most sensitive means of regulation when actuated by an automatic governor, but does not save water. On the other hand, the needle nozzle, while it is extremely economical in the use of water, is difficult to control quickly by means of the governor.

The total available water power of the rivers and streams of the United States has been estimated at two hundred millions horse power, of which only about four millions are now in use. With long distance electrical power transmission, much of this can be brought into immediate utilization. It thus becomes possible, with a proper extension of Hydro-Electric power systems throughout the country to introduce important factors in the industrial world which are now comparatively barren of results.

The extent of the development of this enormous power is beyond prediction by any one now living. The present generation will, however, witness a very great progress. It seems almost that this great natural resource, has been created to meet the unprecedented growth of the population of the United States, whose industrial wants have multiplied at a rate much transcending the rate of its increase. The reign of steam power has been most brilliant; but water power existed and was largely utilized before Watt founded the steam dynasty. I think since it has secured as its ally the inexhaustible resources of electricity its future may yet rival that of steam in its supply of mechanical power.



WORKING EXAMPLES OF SUCCESSFUL STORES MANAGEMENT.

THE SYSTEM AND METHODS OF THE B. F. STURTEVANT COMPANY.

By Walter B. Snow.

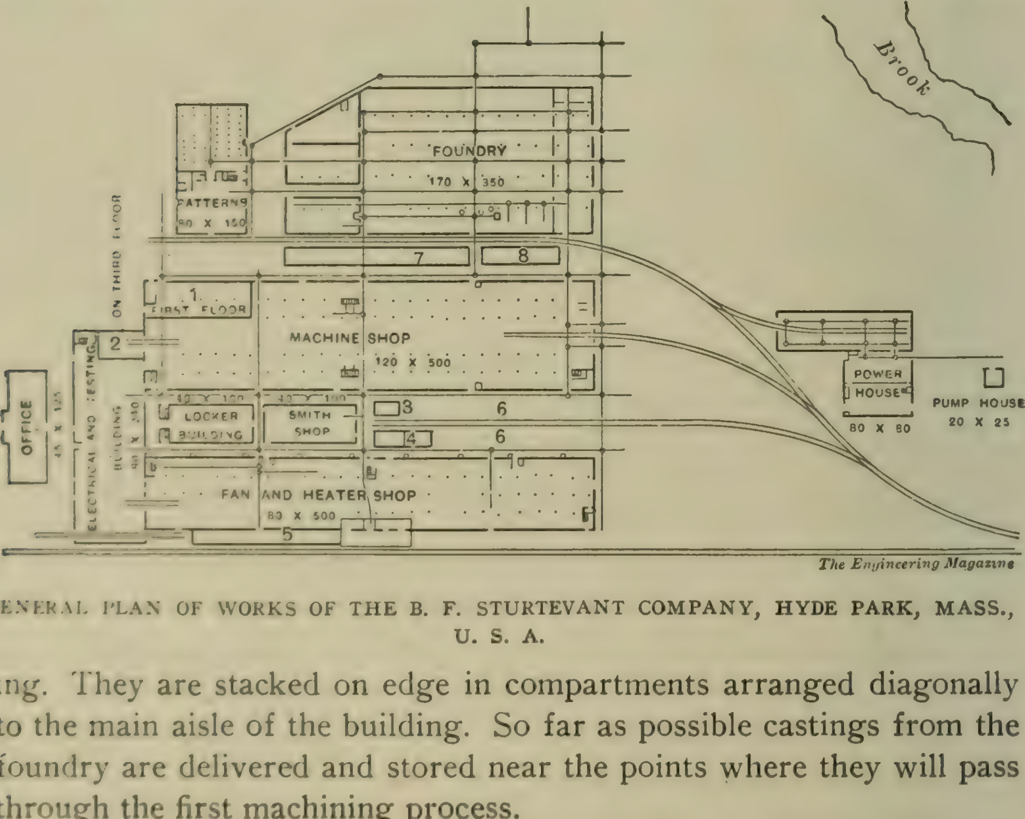
THE buildings of the new plant of the B. F. Sturtevant Co., at Readville, in the town of Hyde Park, Mass., cover a ground area of about five acres; their aggregate floor area exceeds nine acres. They are located beside the freight yards of the N. Y., N. H. & H. R. R., and are arranged in parallel, with five spur tracks, entering or running between the buildings at convenient points. All tracks may be used for receiving merchandise, but those extending into the buildings are usually employed for the shipment of finished products which may be loaded upon the cars by means of traveling cranes.

The great diversity in the character of the products, and of the methods and materials utilized in their production, naturally compels a distinct separation of all departments and, to a lesser extent, of the stores required therein. The general arrangement of stores rooms and storage locations is shown by the accompanying plan. Ordinary supplies of scrap, coke, sand, furnace coal and the like are stored in bins close beside and parallel to the foundry, but separated from it by the steam railroad track from which they are readily unloaded. Pig iron is stored out of doors; each carload being marked with its consecutive analysis number. Steam coal is carried in an open pocket with concrete bottom.

The main stores room in the machine shop serves all departments with general supplies and with standard articles such as bolts, nuts and rivets. A portion of this room is devoted to the storage of the smaller finished parts of engines. In the center craneway of the machine shop completed engine frames are symmetrically piled, while crank shafts are supported upon racks served by an overhead jib crane. The special storeroom in the Electrical Department is there located for convenience of access and only contains articles used exclusively in this department.

In the yard between the machine and fan shops, and adjacent to the forge shop, are stored under lock and key all of the round and flat bar iron, tool steel and the like required in the forge shop. This shed, as well as the piling floor and the racks for angle iron, is located close beside the spur track so that unloading requires the least expenditure of labor. Temporary supplies of bolts, nuts, rivets and the like required only in fan production are maintained at the most accessible points within the fan building. These supplies are periodically replenished from the general stores room.

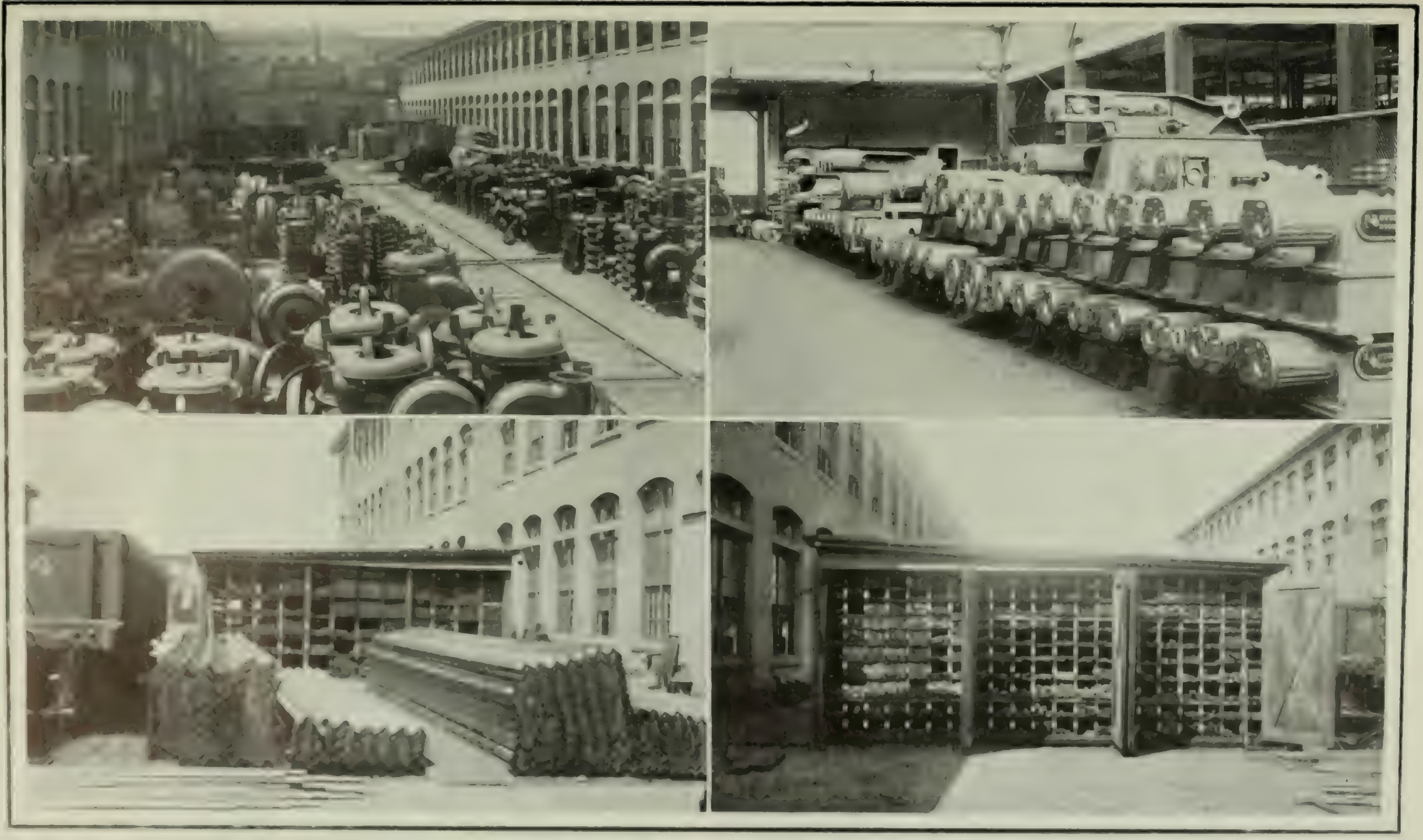
Black iron sheets, of which large quantities and varieties are used, are discharged directly from the cars into the storage building, whence they are drawn as required for working up in the adjoining fan building. They are stacked on edge in compartments arranged diagonally to the main aisle of the building. So far as possible castings from the foundry are delivered and stored near the points where they will pass through the first machining process.



The Engineering Magazine

GENERAL PLAN OF WORKS OF THE B. F. STURTEVANT COMPANY, HYDE PARK, MASS., U. S. A.

All orders for materials issued by the Purchasing Department are based upon formal requisitions from the heads of departments of the form indicated by F 377. The respective requisition numbers appear upon all orders, and shippers are requested to place same on all packages. In certain departments, such as the Plate and Pipe Dept., a weekly inventory of all sheets in stock is taken upon blanks like F 527; the same form being utilized as a part of requisitions and purchase orders.

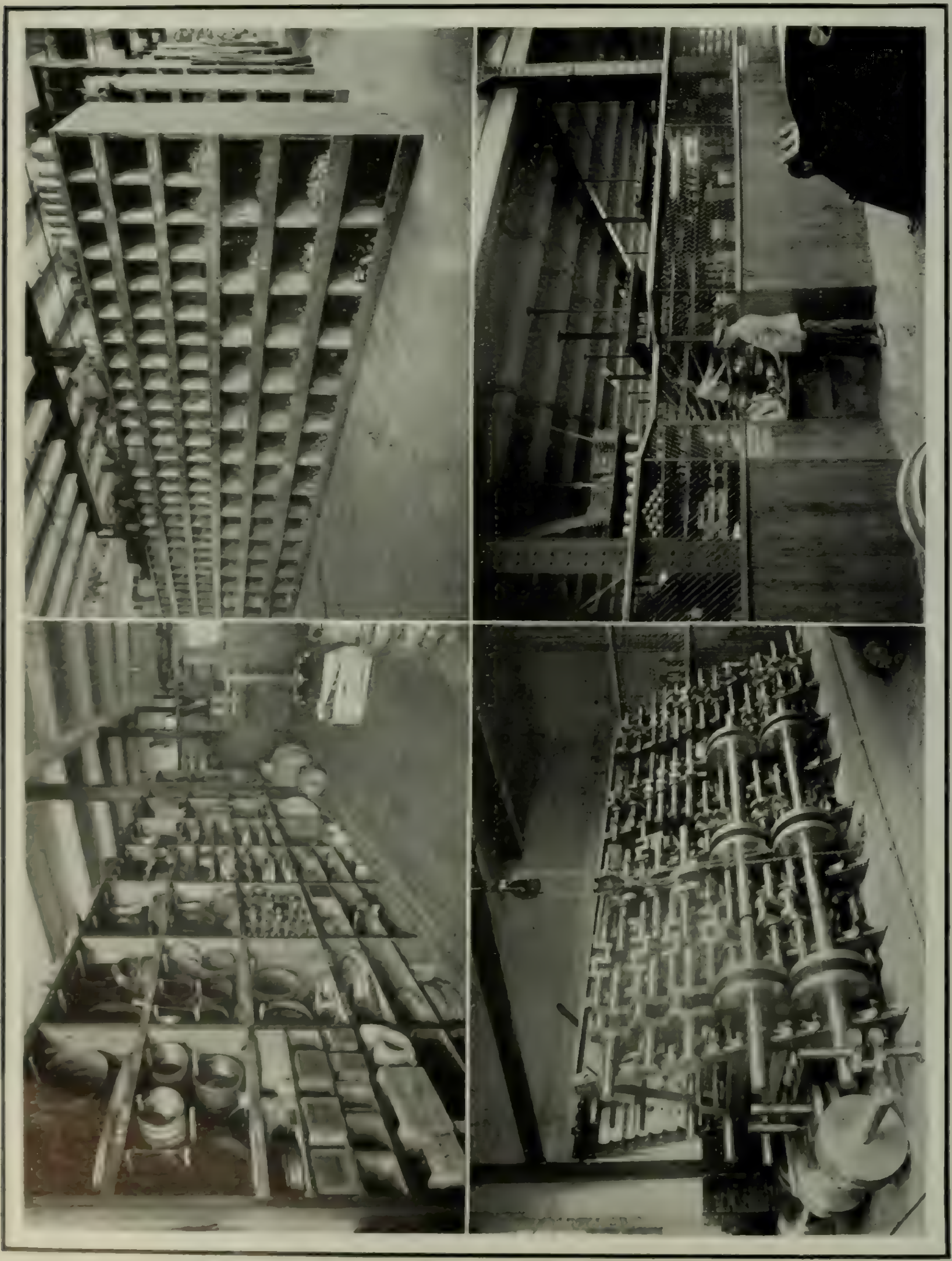


STORES OF B. F. STURTEVANT COMPANY

Storage of Castings in Yard
Storage Floor for Angle Iron and Racks for Small Angles and Large Round Stock

Horizontal Engines Stored in Machine Shop
Storage Racks for Flat and Round Irons

Two manifolds are made of each order on form F 448. One is filed in a consecutive loose leaf binder and the other, minus the price, which is omitted in manifolding, is furnished to the stores keeper. The receipt of goods with weight or number of pieces is noted in a blotter by him, and notation thereof made upon his copy of the purchase order. If said notation indicates that order is filled it is at once returned to the Purchasing Department, and a transcript made in the loose leaf binder file. Form F 541 printed upon the back of each mani-

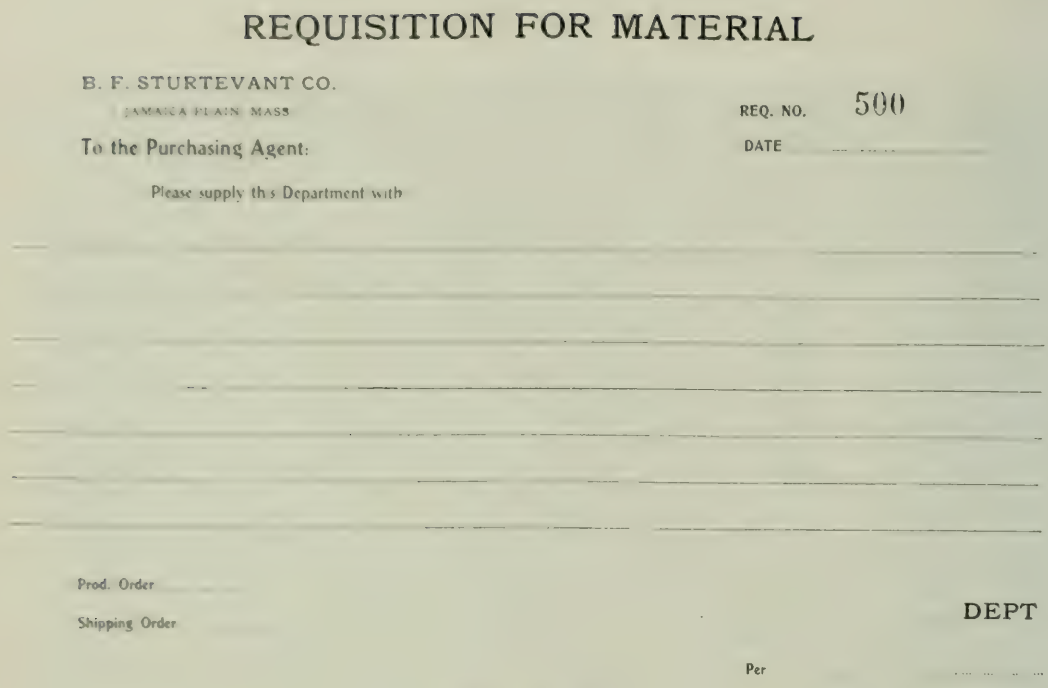


STORAGE ROOMS. B. F. STURTEVANT COMPANY.

Upper Left—Stores Room, Electrical Department. Upper Right—Stores Room, Machine Shop. Lower Left—Storage for Crank Shafts. Lower Right—Delivery Gate, Machine Shop Stores Room.

STORE ROOM FOR VALUABLE METALS AND BRASS CASTINGS IN CONNECTION WITH MACHINE SHOP STORES ROOM.

fold order serves as a place of record regarding the succeeding order which faces it in the book. If only a portion of the order is received, note of the same is made in manifold by the stores keeper. One copy is sent to the Purchasing Department and the other attached to his copy of the order. When the order is completed the stores room copy of the same with attached manifold, or manifolds, is returned to the Purchasing Department. Freight bills are receipted by the stores keeper. The order number to which the same, as well as other transportation, is chargeable is noted thereon, and the amount recorded upon the copy of order.



REQUISITION FOR MATERIAL

B. F. STURTEVANT CO.
JAMAICA PLAIN MASS

REQ. NO. 500

DATE

To the Purchasing Agent:

Please supply this Department with

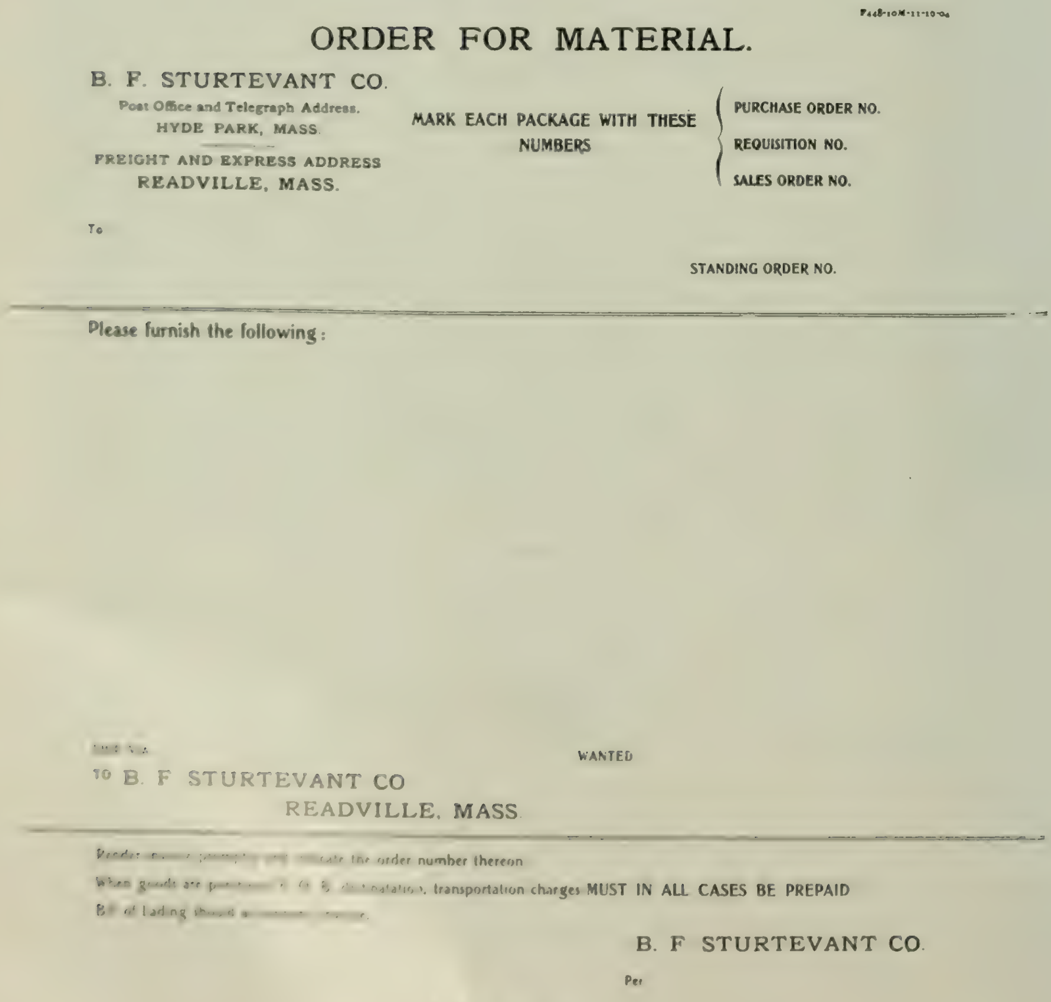
Prod. Order

Shipping Order

DEPT

Per

FORM F-448.
Actual size, 5″ x 8″.



F448-10M-11-10-04

ORDER FOR MATERIAL.

B. F. STURTEVANT CO.
Post Office and Telegraph Address.
HYDE PARK, MASS.

FREIGHT AND EXPRESS ADDRESS
READVILLE, MASS.

MARK EACH PACKAGE WITH THESE NUMBERS
PURCHASE ORDER NO.
REQUISITION NO.
SALES ORDER NO.

To

STANDING ORDER NO.

Please furnish the following:

SHIP VIA

WANTED

TO B. F STURTEVANT CO
READVILLE, MASS

Vendor [illegible] promptly and indicate the order number thereon

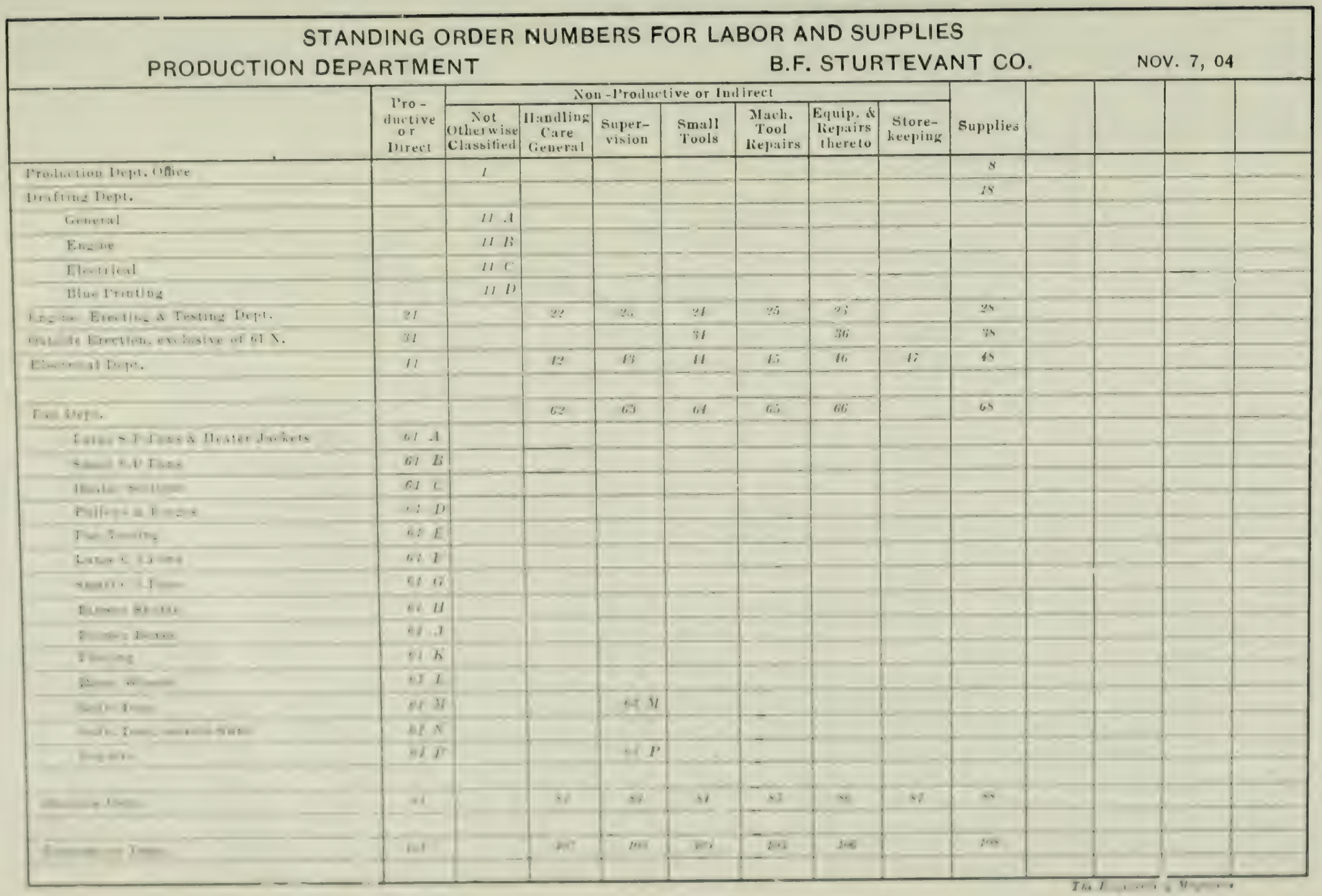
When goods are purchased F. O. B. destination, transportation charges MUST IN ALL CASES BE PREPAID

Bill of Lading should accompany invoice.

B. F STURTEVANT CO.

Per

FORM F-377.
Actual size, 8″ x 10″.



STANDING ORDER NUMBERS FOR LABOR AND SUPPLIES

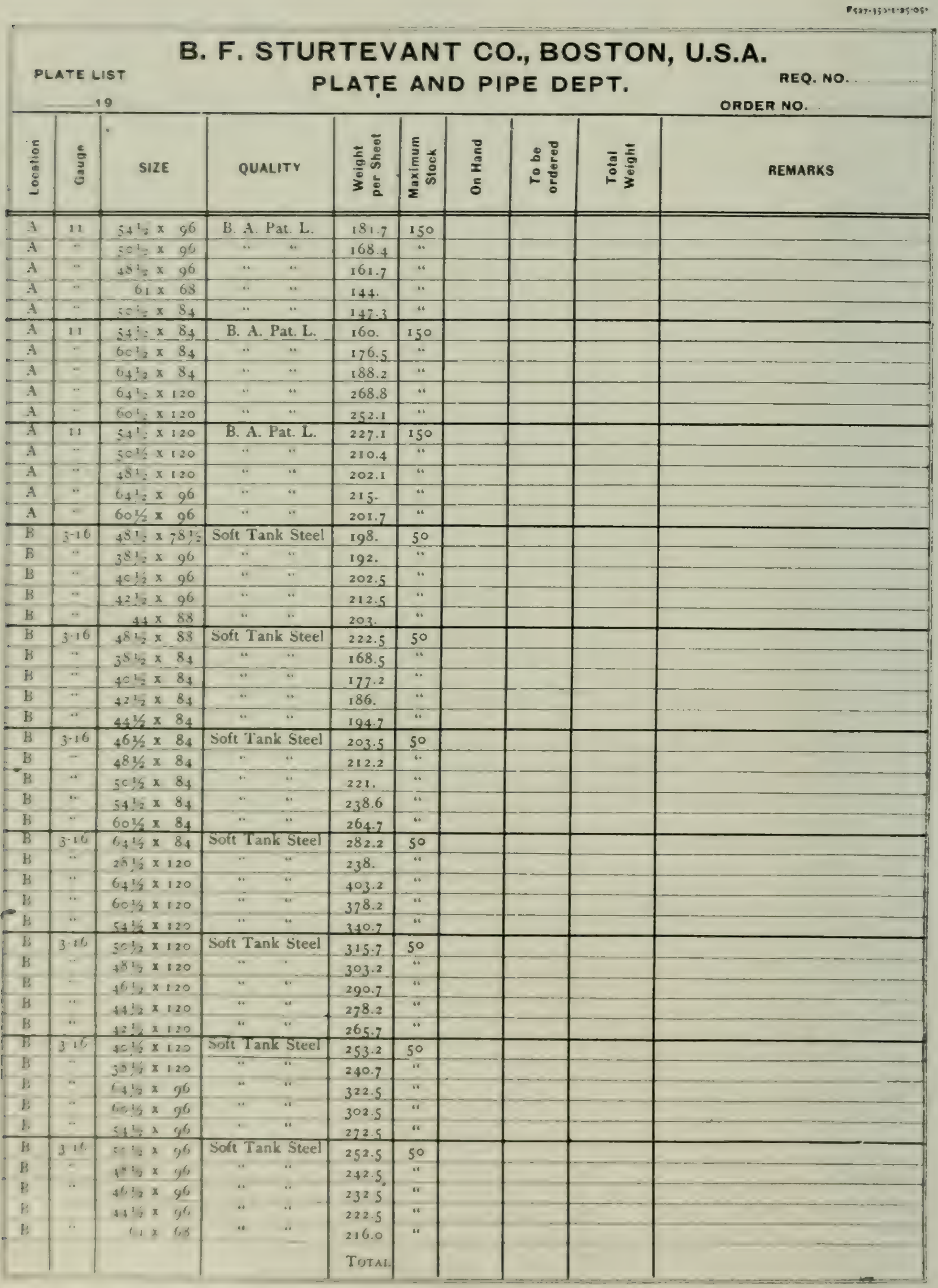
PRODUCTION DEPARTMENT B.F. STURTEVANT CO. NOV. 7, 04

	Pro-ductive or Direct	Non-Productive or Indirect							Supplies				
		Not Otherwise Classified	Handling Care General	Super-vision	Small Tools	Mach. Tool Repairs	Equip. & Repairs thereto	Store-keeping					
Production Dept. Office		*1*							*8*				
Drafting Dept.									*18*				
General		*11 A*											
Engine		*11 B*											
Electrical		*11 C*											
Blue Printing		*11 D*											
Engine Erecting & Testing Dept.	*21*		*22*	*23*	*24*	*25*	*26*		*28*				
Outside Erection, exclusive of 61 N.	*31*				*34*		*36*		*38*				
Electrical Dept.	*41*		*42*	*43*	*44*	*45*	*46*	*47*	*48*				
Fan Dept.			*62*	*63*	*64*	*65*	*66*		*68*				
Large S.F. Fans & Heater Jackets	*61 A*												
Small S.F. Fans	*61 B*												
[illegible]	*61 C*												
Pulleys & [illegible]	*61 D*												
Fan Testing	*61 E*												
[illegible]	*61 F*												
[illegible]	*61 G*												
[illegible]	*61 H*												
[illegible]	*61 J*												
[illegible]	*61 K*												
[illegible]	*61 L*												
[illegible]	*61 M*			*61 M*									
[illegible]	*61 N*												
[illegible]	*61 P*			*61 P*									
[illegible] Dept.	*81*		*82*	*83*	*84*	*85*	*86*	*87*	*88*				
[illegible]	*101*		*102*	*103*	*104*	*105*	*106*		*108*				

The Engineering Magazine

FORM T-3753.

Actual width, 9½". Only part of the list shown.



F527-350-1-25-05

B. F. STURTEVANT CO., BOSTON, U.S.A.

PLATE LIST **PLATE AND PIPE DEPT.** **REQ. NO.**

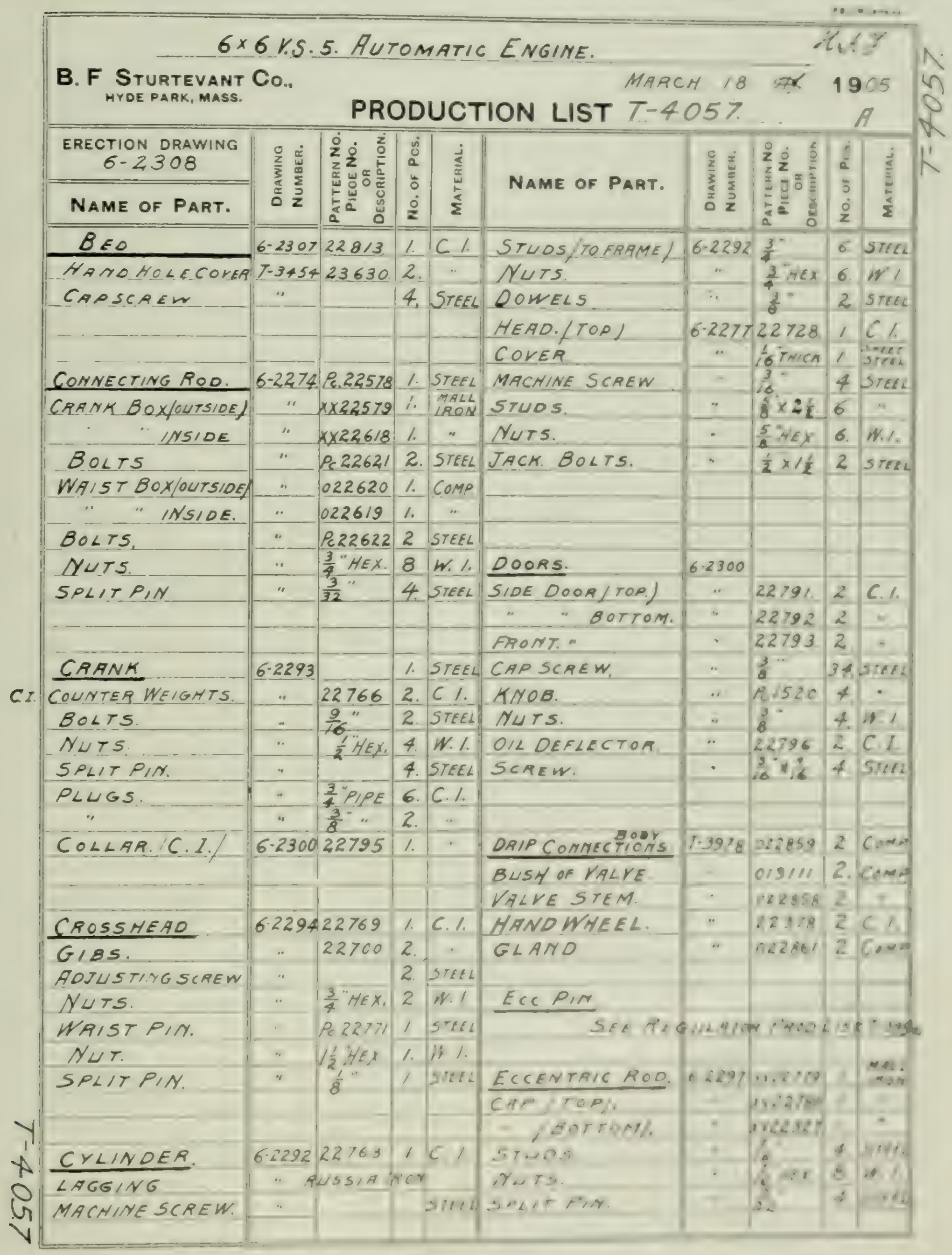
______ 19 **ORDER NO.**

Location	Gauge	SIZE	QUALITY	Weight per Sheet	Maximum Stock	On Hand	To be ordered	Total Weight	REMARKS
A	11	54½ x 96	B. A. Pat. L.	181.7	150				
A	"	50½ x 96	" "	168.4	"				
A	"	48½ x 96	" "	161.7	"				
A	"	61 x 68	" "	144.	"				
A	"	50½ x 84	" "	147.3	"				
A	11	54½ x 84	B. A. Pat. L.	160.	150				
A	"	60½ x 84	" "	176.5	"				
A	"	64½ x 84	" "	188.2	"				
A	"	64½ x 120	" "	268.8	"				
A	"	60½ x 120	" "	252.1	"				
A	11	54½ x 120	B. A. Pat. L.	227.1	150				
A	"	50½ x 120	" "	210.4	"				
A	"	48½ x 120	" "	202.1	"				
A	"	64½ x 96	" "	215.	"				
A	"	60½ x 96	" "	201.7	"				
B	3-16	48½ x 78½	Soft Tank Steel	198.	50				
B	"	38½ x 96	" "	192.	"				
B	"	40½ x 96	" "	202.5	"				
B	"	42½ x 96	" "	212.5	"				
B	"	44 x 88	" "	203.	"				
B	3-16	48½ x 88	Soft Tank Steel	222.5	50				
B	"	38½ x 84	" "	168.5	"				
B	"	40½ x 84	" "	177.2	"				
B	"	42½ x 84	" "	186.	"				
B	"	44½ x 84	" "	194.7	"				
B	3-16	46½ x 84	Soft Tank Steel	203.5	50				
B	"	48½ x 84	" "	212.2	"				
B	"	50½ x 84	" "	221.	"				
B	"	54½ x 84	" "	238.6	"				
B	"	60½ x 84	" "	264.7	"				
B	3-16	64½ x 84	Soft Tank Steel	282.2	50				
B	"	28½ x 120	" "	238.	"				
B	"	64½ x 120	" "	403.2	"				
B	"	60½ x 120	" "	378.2	"				
B	"	54½ x 120	" "	340.7	"				
B	3-16	50½ x 120	Soft Tank Steel	315.7	50				
B	"	48½ x 120	" "	303.2	"				
B	"	46½ x 120	" "	290.7	"				
B	"	44½ x 120	" "	278.2	"				
B	"	42½ x 120	" "	265.7	"				
B	3-16	40½ x 120	Soft Tank Steel	253.2	50				
B	"	38½ x 120	" "	240.7	"				
B	"	64½ x 96	" "	322.5	"				
B	"	60½ x 96	" "	302.5	"				
B	"	54½ x 96	" "	272.5	"				
B	3-16	50½ x 96	Soft Tank Steel	252.5	50				
B	"	48½ x 96	" "	242.5	"				
B	"	46½ x 96	" "	232.5	"				
B		44½ x 96	" "	222.5	"				
B	"	61 x 68	" "	216.0	"				
				TOTAL					

FORM F-527.
Actual size, 7½" x 9⅜".

The principal stores room which occupies one corner of the machine shop, adjacent to the erecting shop and testing plates, measures 40 ft. x 120 ft., and is 17 ft. high. Wooden bins are provided for the storage of small pieces in quantity. Articles from which temporary supplies are elsewhere maintained are kept in the original packages.

Finished parts are carried upon shelves which are supported upon cast iron brackets clamped around pipe columns extending from floor to ceiling. Metals, other than iron, small forgings, brass, steel, malleable iron and similar castings, are stored in suitable bins. All castings and forgings are designated by pattern or piece numbers. Castings received from the brass foundry are listed on a special form which



6 x 6 V.S. 5. AUTOMATIC ENGINE. [illegible]

B. F STURTEVANT CO.,
HYDE PARK, MASS.

MARCH 18 ~~[illegible]~~ 1905

PRODUCTION LIST T-4057.
A

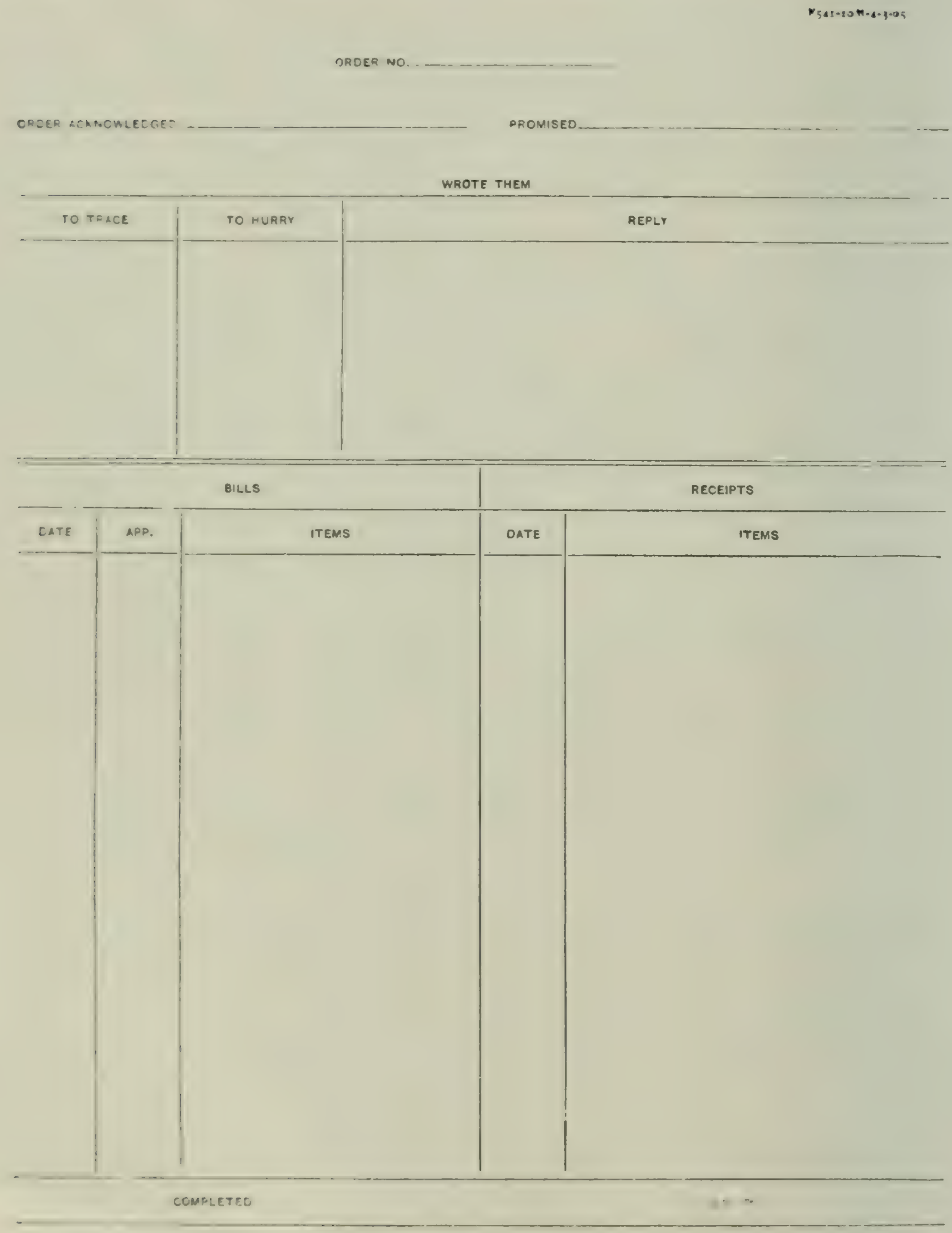
T-4057

ERECTION DRAWING 6-2308

NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.	NAME OF PART.	DRAWING NUMBER.	PATTERN NO. PIECE NO. OR DESCRIPTION.	NO. OF PCS.	MATERIAL.
BED	6-2307	22813	1.	C. I.	STUDS (TO FRAME)	6-2292	3/4"	6	STEEL
HAND HOLE COVER	T-3454	23630	2.	"	NUTS.	"	3/4" HEX	6.	W. I.
CAPSCREW	"		4.	STEEL	DOWELS	"	3/8"	2	STEEL
					HEAD. (TOP)	6-2277	22728	1	C. I.
					COVER	"	1/16" THICK	1	SHEET STEEL
CONNECTING ROD.	6-2274	Pc. 22578	1.	STEEL	MACHINE SCREW	"	3/16"	4	STEEL
CRANK BOX (OUTSIDE)	"	XX22579	1.	MALL IRON	STUDS.	"	5/8 x 2 1/2	6	"
" " INSIDE	"	XX22618	1.	"	NUTS.	"	5/8" HEX	6.	W. I.
BOLTS	"	Pc 22621	2.	STEEL	JACK. BOLTS.	"	1/2 x 1 1/2	2	STEEL
WAIST BOX (OUTSIDE)	"	022620	1.	COMP					
" " INSIDE.	"	022619	1.	"					
BOLTS,	"	Pc 22622	2	STEEL					
NUTS.	"	3/4" HEX.	8	W. I.	DOORS.	6-2300			
SPLIT PIN	"	3/32"	4.	STEEL	SIDE DOOR (TOP.)	"	22791.	2	C. I.
					" " BOTTOM.	"	22792	2	"
					FRONT. "	"	22793	2	"
CRANK	6-2293		1.	STEEL	CAP SCREW,	"	3/8"	34	STEEL
C.I. COUNTER WEIGHTS.	"	22766	2.	C. I.	KNOB.	"	P. 1520	4	"
BOLTS.	"	9/16"	2.	STEEL	NUTS.	"	3/8"	4.	W. I.
NUTS.	"	1/2" HEX.	4.	W. I.	OIL DEFLECTOR	"	22796	2	C. I.
SPLIT PIN.	"		4.	STEEL	SCREW.	"	3/16" x 9/16	4	STEEL
PLUGS.	"	3/4" PIPE	6.	C. I.					
"	"	3/8" "	2.	"					
COLLAR. (C. I.)	6-2300	22795	1.	"	DRIP CONNECTIONS BODY	T-3978	022859	2	COMP
					BUSH OF VALVE	"	019111	2.	COMP
					VALVE STEM.	"	022858	2	"
CROSSHEAD	6-2294	22769	1.	C. I.	HAND WHEEL.	"	22878	2	C. I.
GIBS.	"	22700	2.	"	GLAND	"	022861	2	COMP
ADJUSTING SCREW	"		2.	STEEL					
NUTS.	"	3/4" HEX.	2	W. I.	ECC PIN				
WRIST PIN.	"	Pc 22771	1	STEEL	SEE REGULATION PROD LIST T-[illegible]				
NUT.	"	1 1/2" HEX	1.	W. I.					
SPLIT PIN.	"	1/8"	1	STEEL	ECCENTRIC ROD.	6-2297	[illegible]	[illegible]	MAL. IRON
					CAP (TOP).	"	[illegible]	[illegible]	[illegible]
					" (BOTTOM).	"	[illegible]	[illegible]	"
CYLINDER.	6-2292	22763	1	C. I.	STUDS	"	[illegible]	4	STEEL
LAGGING	"	RUSSIA IRON			NUTS.	"	[illegible] HEX	8	W. I.
MACHINE SCREW.	"			STEEL	SPLIT PIN.	"	[illegible]/32	4	STEEL

T-4057

FORM T-4057.
Actual size, 8½" x 11".



F541-10M-4-3-05

ORDER NO. ____________

ORDER ACKNOWLEDGED ____________ PROMISED ____________

WROTE THEM

TO TRACE	TO HURRY	REPLY

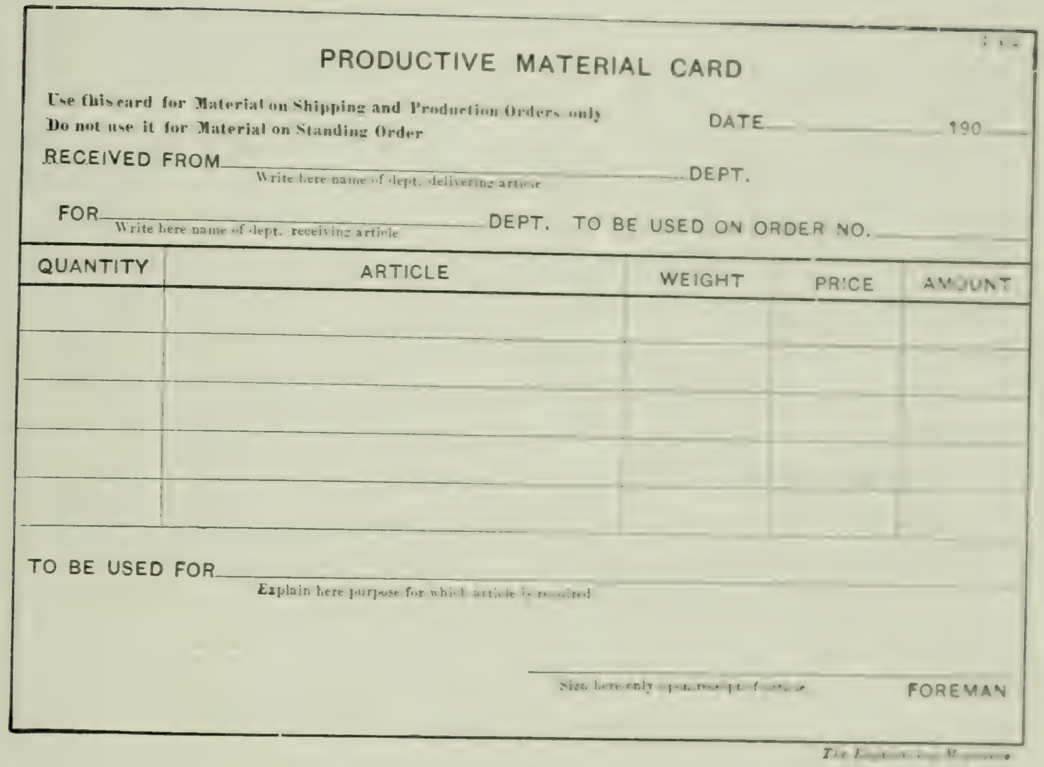
BILLS			RECEIPTS	
DATE	APP.	ITEMS	DATE	ITEMS

COMPLETED

FORM F-541.
Current Order Record. Actual size, 8" x 10".

is made and receipted in manifold. One copy is retained in the stores room and the other is passed to the Production Department.

Material delivered from the stores room is receipted for upon Productive or Non-Productive Material Cards, (F 472 printed on white, and F 473 printed on pink paper) according to the character of the material. Productive material is classed as that which forms a



PRODUCTIVE MATERIAL CARD

Use this card for Material on Shipping and Production Orders only
Do not use it for Material on Standing Order

DATE ______ 190__

RECEIVED FROM ______ DEPT.
Write here name of dept. delivering article

FOR ______ DEPT. TO BE USED ON ORDER NO. ______
Write here name of dept. receiving article

QUANTITY	ARTICLE	WEIGHT	PRICE	AMOUNT

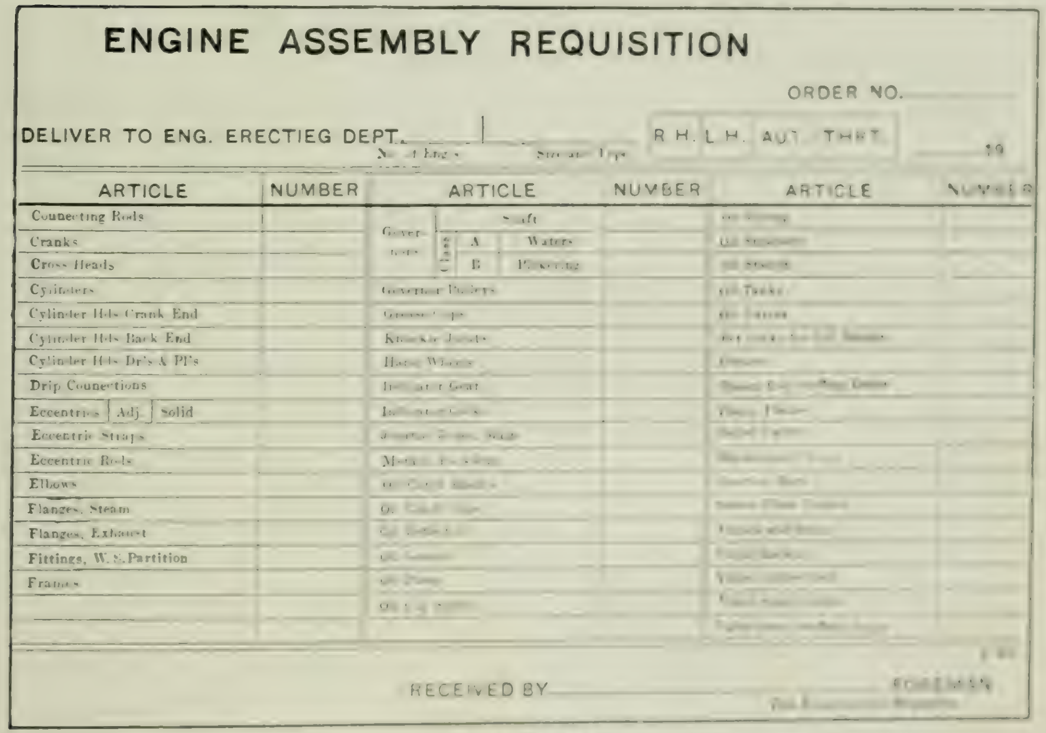
TO BE USED FOR ______
Explain here purpose for which article is required

______ FOREMAN
Sign here only upon receipt of article

The Engineering Magazine

FORM F-472.

Printed on white paper. Actual size, 4" x 6".



ENGINE ASSEMBLY REQUISITION

ORDER NO. ______

DELIVER TO ENG. ERECTIEG DEPT. ______ | ______ R. H. | L. H. | AUT. | THRT. ______ 19__
No. of Engs. Size and Type

ARTICLE	NUMBER	ARTICLE	NUMBER	ARTICLE	NUMBER
Connecting Rods		Governors Shaft		[illegible]	
Cranks		A Waters		Oil Strainers	
Cross Heads		B [illegible]		[illegible]	
Cylinders		Governor Pulleys		Oil Tanks	
Cylinder Hds Crank End		Grease Cups		[illegible]	
Cylinder Hds Back End		Knuckle Joints		[illegible]	
Cylinder Hds Dr's & Pl's		Hand Wheels		[illegible]	
Drip Connections		Indicator Gear		[illegible]	
Eccentrics | Adj. | Solid		Indicator Cocks		[illegible]	
Eccentric Straps		[illegible]		[illegible]	
Eccentric Rods		Metallic Packing		[illegible]	
Elbows		[illegible]		[illegible]	
Flanges, Steam		[illegible]		[illegible]	
Flanges, Exhaust		[illegible]		[illegible]	
Fittings, W. S. Partition		[illegible]		[illegible]	
Frames		[illegible]		[illegible]	
		[illegible]		[illegible]	
				[illegible]	

RECEIVED BY ______ FOREMAN

The Engineering Magazine

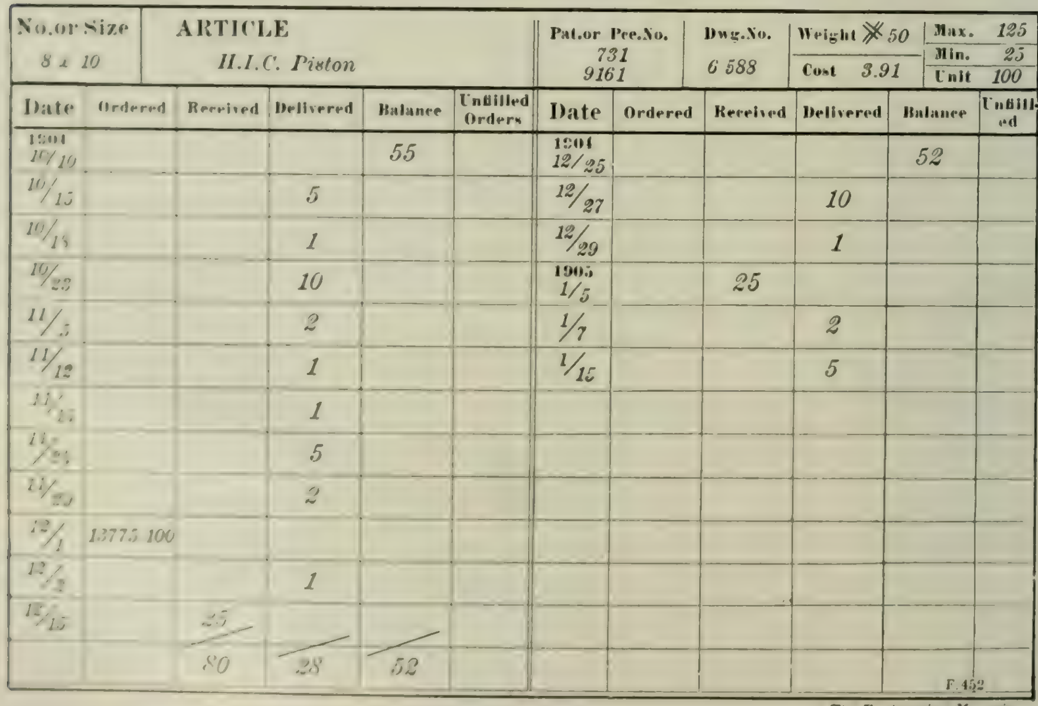
FORM F-471

Actual size, 4" x 6".

part of, or accompanies, the completed sales product when it leaves the works. Such is iron, steel, paint, slush, wrapping paper, packing lumber, nails, etc. All other material is classed as non-productive and includes such articles as waste, oil, brushes, shovels, coal, gas, water, moulding sand, etc., which are required for operation, maintenance or equipment and accessory to the manufacturing but which do not form a part of the completed product. The general classification of all material and labor is established by a system of standing order numbers as presented by T-3753. The integer in each case indicates the division to which the expense is to be charged, while the preceding figure or figures serve to designate the department. For instance, all numbers for supplies end in "8," while all numbers for the Fan Department begin with "6". Hence, "68" indicates supplies for Fan Department. The proper standing order number when entered upon the material card serves to instantly classify the same.

Group requisitions from the Erecting Department are served on finished stores by means of special forms such, for instance, as F 471, which calls for all the parts essential to the assembling of a given engine.

Oil is stored in tanks beneath a fire proof floor in an independent oil house. Thence it is pumped into individual 10 gallon "pump cans" which are distributed to the various sub-departments.



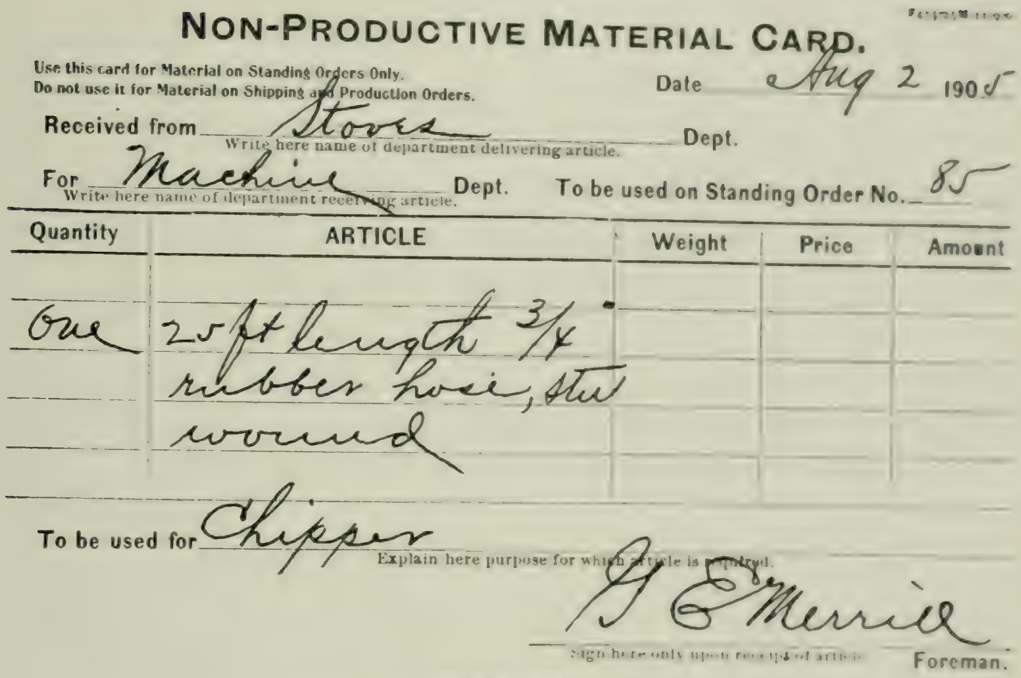
No. or Size 8 x 10	**ARTICLE** H.I.C. Piston	**Pat. or Pce. No.** 731 9161	**Dwg. No.** 6 588	**Weight** ✕ 50 **Cost** 3.91	**Max.** 125 **Min.** 25 **Unit** 100

Date	Ordered	Received	Delivered	Balance	Unfilled Orders	Date	Ordered	Received	Delivered	Balance	Unfilled
1904 10/10				55		1904 12/25				52	
10/15			5			12/27			10		
10/18			1			12/29			1		
10/23			10			1905 1/5		25			
11/5			2			1/7			2		
11/12			1			1/15			5		
11/17			1								
11/24			5								
11/29			2								
12/1	13775 100										
12/2			1								
12/15		25									
		80	28	52							

F. 452

The Engineering Magazine

FORM F-452.



NON-PRODUCTIVE MATERIAL CARD.

Use this card for Material on Standing Orders Only.
Do not use it for Material on Shipping and Production Orders.

Date Aug 2 1905

Received from Stores Dept.
Write here name of department delivering article.

For Machine Dept. To be used on Standing Order No. 85
Write here name of department receiving article.

Quantity	ARTICLE	Weight	Price	Amount
One	25 ft length 3/4" rubber hose, steel wound			

To be used for Chipper
Explain here purpose for which article is required.

G. E. Merrill
Sign here only upon receipt of article. Foreman.

FORM F-473.
Printed on pink paper. Actual size, 4" x 6".

Waste made up into one-quarter pound balls is regularly delivered on Saturday mornings to foremen, in quantities specified on their individual requisitions, and by them delivered to the workmen in their respective departments. Files (distributed from the tool room) brushes, shovels, riddles and the like are delivered only on requisitions from general foremen and are not replaced without the presentation of a new requisition.

A running inventory of finished parts and completed machines is maintained upon cards like F 452. Notations thereon are made upon issuance of production orders, and upon reports of receipts and deliveries from the stores room. The inventory of completed machines serves as the basis of weekly stock lists, copies of which are furnished to local salesmen and to all branch offices.

Detailed production lists (see T-4057) are employed as a basis for determining the drawing, pattern and piece numbers, kind of material and quantities required in manufacturing specific machines. They are also utilized in the figuring of aggregate costs. Every piece is thereby accounted for and there is no reasonable opportunity for omission or inaccuracy.

The methods employed by the B. F. Sturtevant Co. are not those of a ready made system. They have grown with the concern during its progressive life of forty odd years. They fit the business because they are an evolution of it.

HOISTING PRACTICE IN THE PENNSYLVANIA ANTHRACITE REGION.

By R. V. Norris.

THE days when Anthracite coal was largely mined from drifts or tunnels above water level have almost passed into ancient history, and at the present time all but an insignificant proportion of the 60,000,000 tons or more annually produced is hoisted from shafts or slopes. This, with the very large outputs from single collieries, and the low price of fuel, has developed a hoisting practice somewhat unique in many ways, but, while much is well suited to the conditions, there are many survivals of very ancient and extravagant engines and steam plants, which remind one of Bret Harte's lines.

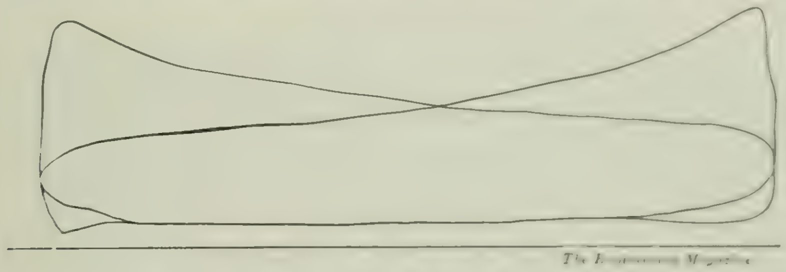
> "Of all sad words of tongue or pen
> The saddest are it might have been,
> More sad than these we daily see,
> *It is, but hadn't ought to be."*

To give an idea of the extent of hoisting done, the last Mine Inspectors Report—1903—states that there were in use in the region 4652 engines of 425,209 aggregate horsepower; this includes all engines, but the greater majority are hoisting engines—2476 cylinder; and 2256 tubular and water tube boilers of 413,441 aggregate horsepower. The antediluvian engines usually go with the equally obsolete cylinder boilers.

The early engines were single engines with hook valve motion, geared to wood lagged drums, often having but a single eccentric. The engine was started with a starting bar before the hook was dropped in place, and lowering was accomplished entirely by the manual moving of the valve with the starting bar. Indicator cards from such an engine without explanation, would be practically undecipherable to even an expert.

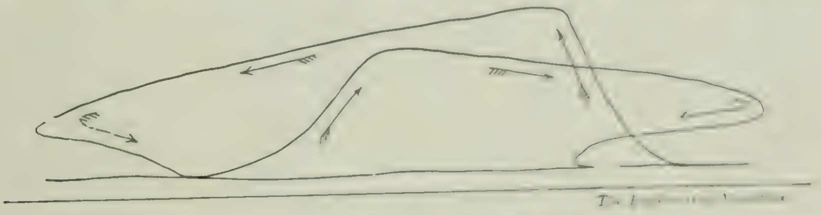
Geared engines are still very largely used for slopes and comparatively shallow shafts. Such engines are, however, pairs of modern link motion engines, usually with cast gears and wood lagged drums, and provided with the necessary auxiliaries. These engines have advantages in first cost—requiring only moderate boiler plants—and are good practice where the time of hoist is not a material factor. The engines are usually of rather long stroke, 18″ x 36″, and 18″ x 48″ being favorite sizes of cylinders. The large diameter drums, required for the large ropes and heavy loads hoisted, are suited to a speed reduction for moderate lifts.

For important hoists, first motion engines are generally used. Such engines are built to rigid specifications, and the requirements are most severe, often over 1000 feet per minute piston speed, with reversing under full steam pressure at full speed. The engines are provided with power reverse and brake, cast grooved drums—frequently coned; steel cranks and cross heads; tail rods; special throttle; overwinding valves, and enormously heavy beds.



The Engineering Magazine

SINGLE, GEARED, 12″ x 14″ ENGINE.
Wood lagged drum. Hoisting.



The Engineering Magazine

SINGLE, GEARED, 12″ x 14″ ENGINE.
Wood lagged drum. Lowering.

A pair of 36″ x 60″ engines built for the Lytle Coal Co. hoist a tank containing 2,600 gallons (10 tons) of water from a 1,550 foot shaft in 45 seconds.*

To take up in detail the modern anthracite practice in hoisting engines, the bed plates are now usually of the trunk type with bored guides, the bed plate, often made in two parts for convenience in handling, and the end of the cylinder on large engines supported by a special stand. The foundations are usually of concrete, with bolts so arranged that the lower ends are accessible through tunnels in the foundation. The bottoms of the bolts are secured either by nuts, locked by special boxes on the foundation washers, or by enlarging the lower end and using keys, the latter practice having advantages in removing bolts in the somewhat circumscribed space or the bolt tunnels.

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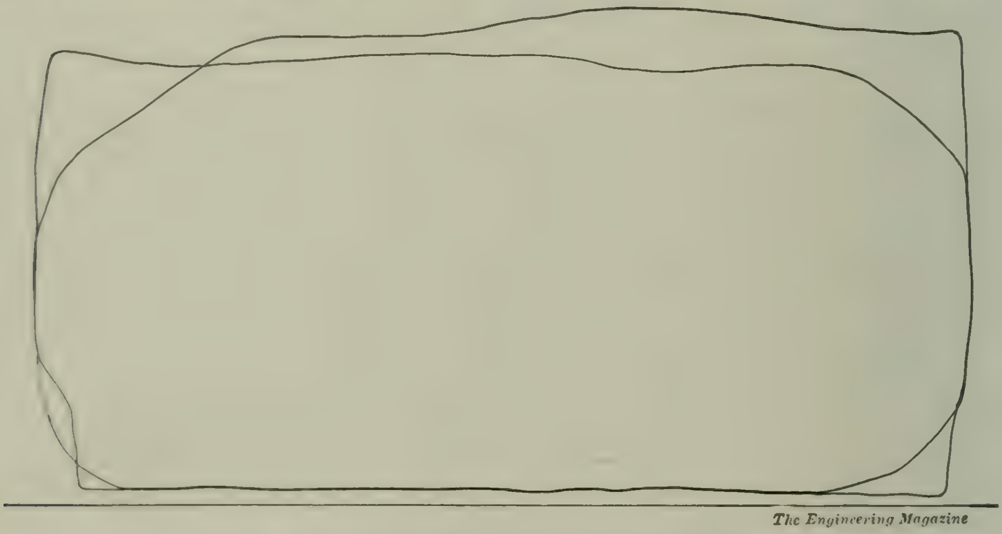
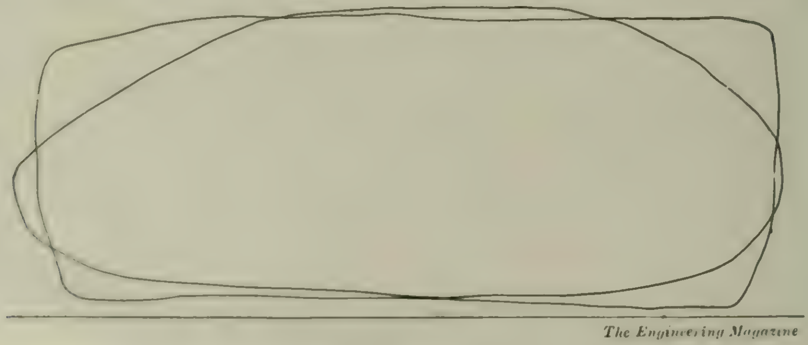
* Transactions of the American Institute of Mining Engineers, Vol. XXXIV, page [illegible]. These engines were designed for [illegible] pounds steam pressure, and every part was made unusually heavy for the very severe work required.

Cast coned drums, are largely used on first motion engines, these were introduced into the region before 1880, the earlier drums were coned toward the centre from a fear that the rope might slip from the cone, this construction, however, greatly reduces the strength of the drum as a beam, and the engines thus designed have always suffered from breakages at or near the small centre of the drums. As experience proved that the danger of the rope's slipping down the cone existed only in the imagination of the earlier designers, the modern engines are always built with the larger portion of the drum in the centre.



FIRST MOTION HOISTING ENGINES, 30″ x 48″.

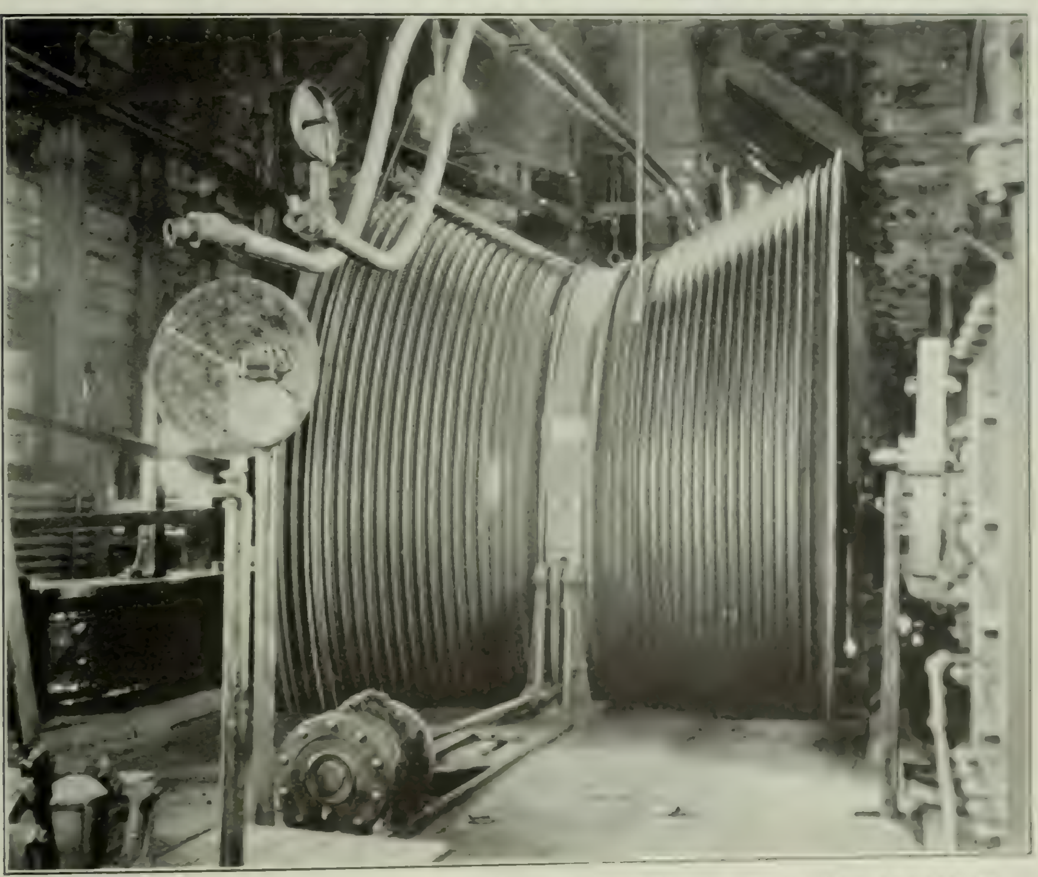
Short Mountain Slope, Lykens Coal Co.



GEARED HOISTING ENGINE, 12″ x 20″.

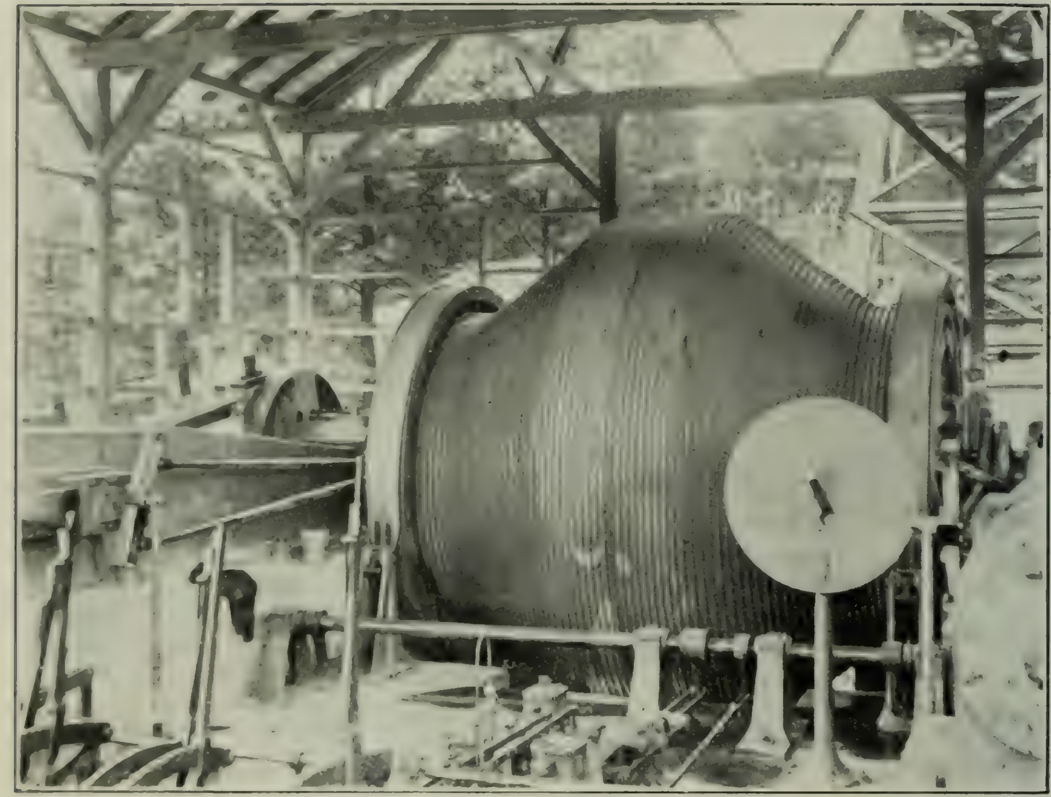
Bear Valley No. 1 Shaft, Summit Branch Mining Co.

The brake in use is almost invariably of the strap type. The band itself may be wood lined, or an iron band may grip a wood lagged brake sheave or drum; the former has the advantage of cheapness, a single board being bent to form the lagging and it is easier to replace than the blocks required on the sheave or drum. Asbestos lagging is rapidly coming into use, and, when properly treated, is a decided success, showing but very slight wear after years of service. The brakes on the smaller engines are usually hand operated; but on the modern large first motion engines power brakes are in almost universal use. The earliest of these put on in the early 80's was a simple steam cylinder supplied by a three-way valve; this applied the brake with lightning rapidity and resulting shock to the mechanism, and a glorious smoke from the overheated brake band, and kept it on as long as the valve was open, or until the steam condensed after the valve was closed. The brakes on modern engines are applied through a "reversing engine" which moves the brake band in direct relation



DRUM FOR 30″ x 72″ HOISTING ENGINES, NO. 1 SHAFT, SUSQUEHANNA COAL CO., NANTICOKE, PA.

Built about 1880. Small diameter of drum in centre. One of the earliest coned drums built.

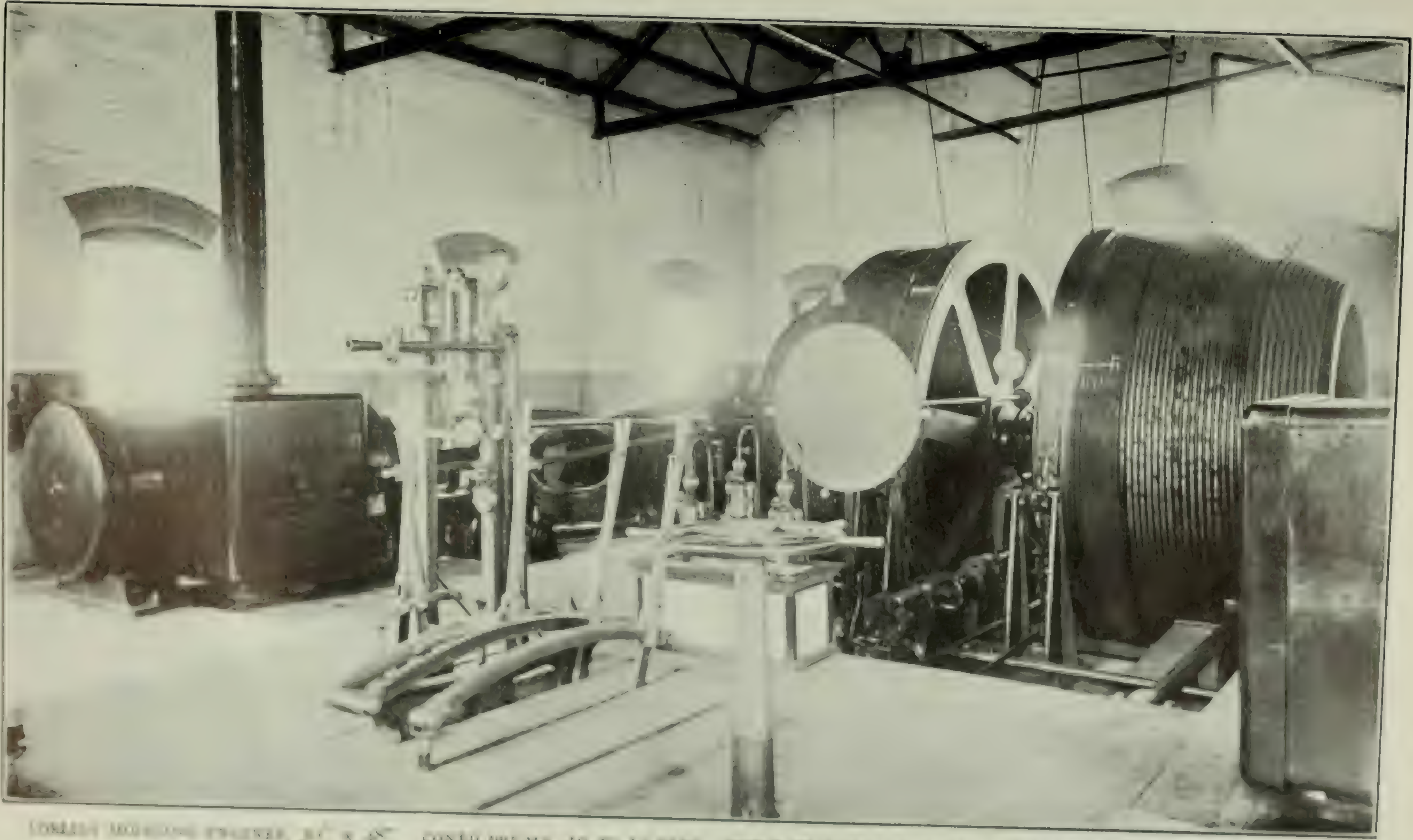


LYTLE SHAFT 36″ x 60″ HOISTING ENGINE.
Drum coned 10 to 16 feet diameter.

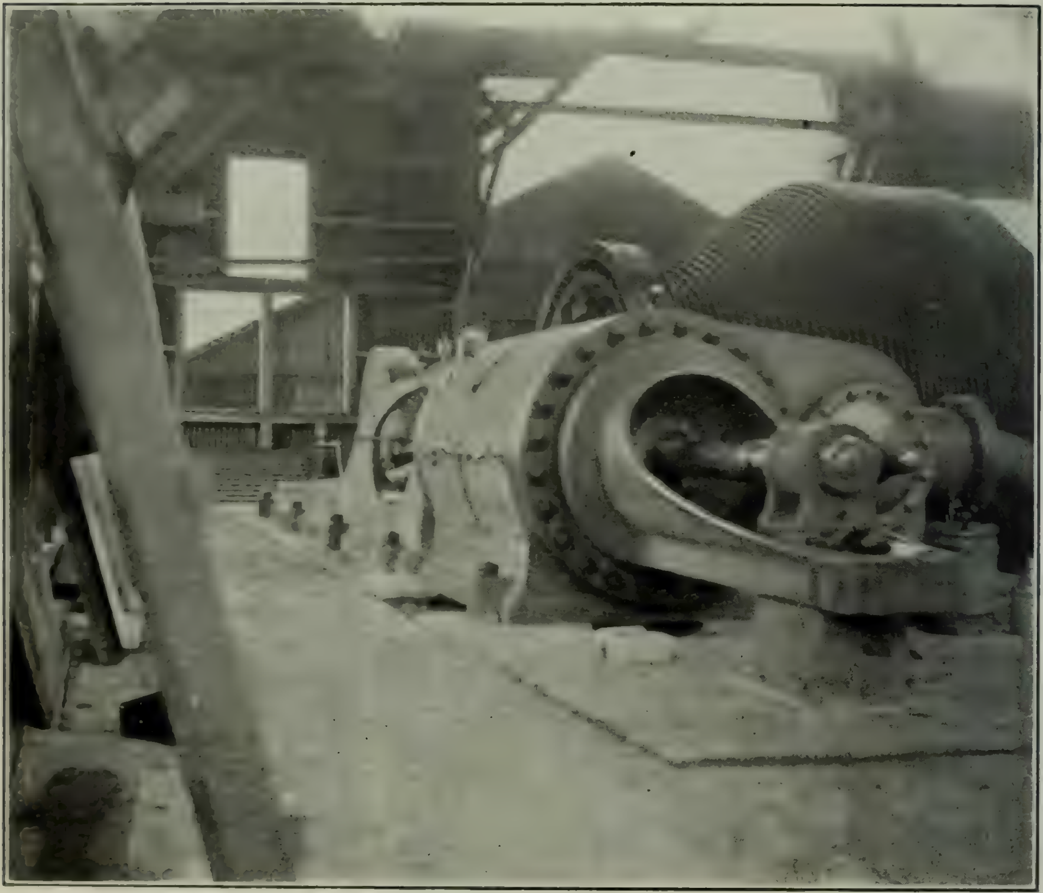
to the movement of the engineers actuating lever. Standard air brakes are also used by which the brake pressure is controlled by the movement of the "engineers valve." With the air brake a standard locomotive automatic compressor is used to supply the necessary air. While the operation of the reversing engine and air brakes are about on a par, the latter has the advantage of "staying put" until released, while the former loses its power by condensation.

In cases where it is necessary to hoist from more than one level in a double shaft, either the well known Whiting system is used, or, more frequently, the engine is built with one loose and one fast drum. The former secured by a jaw clutch is released and held by its special brake, and the change in rope length is made by moving the engine, when the jaw clutch is again engaged. This clutch must necessarily be capable of rather fine adjustment and takes the form of a face wheel of large pitch on the drum, with a similar wheel sliding on the shaft engaging with it as a clutch.

The engine shaft is generally designed as a beam to resist the maximum load on the drum. While this gives an unnecessarily heavy shaft, it has the advantage of very large bearings, and by its small



CORLISS HOISTING ENGINES, 32" x 48". CONED DRUMS, 10 TO 14 FEET. BUILT BY THE VULCAN IRON WORKS, WILKES-BARRE, PA., U. S. A., FOR THE MAXWELL SHAFT OF THE LEHIGH AND WILKES-BARRE COAL CO.



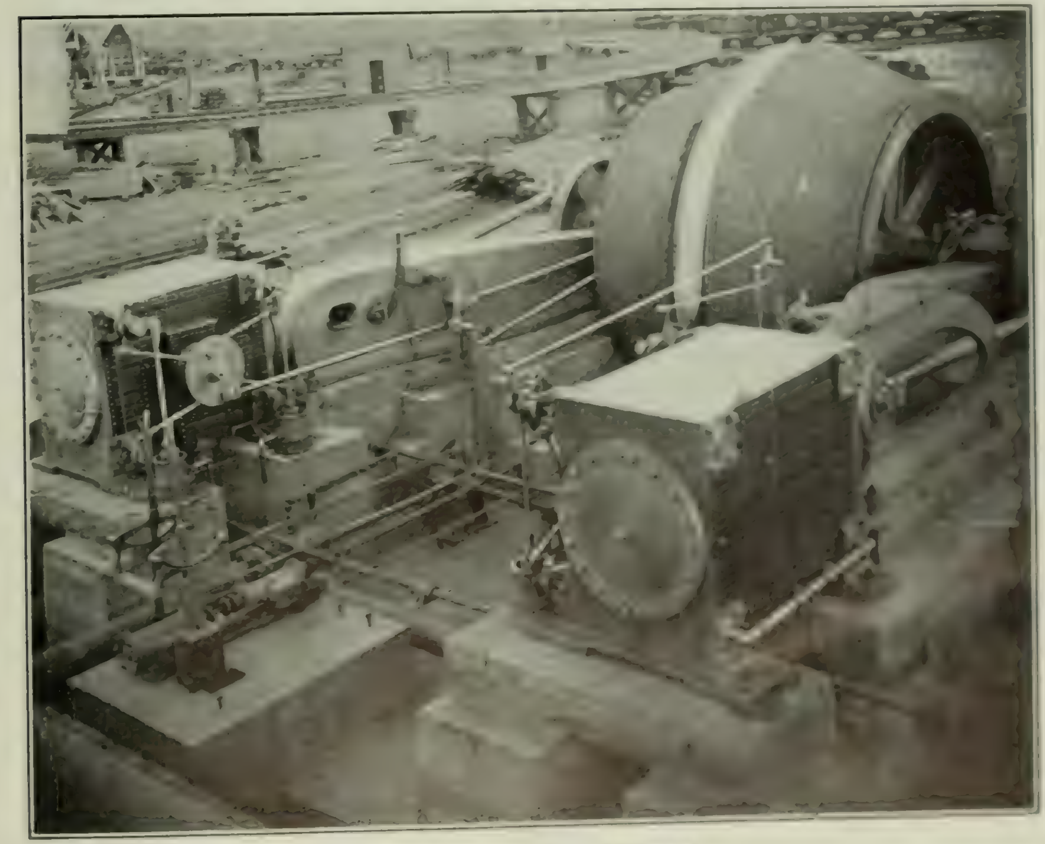
LYTLE SHAFT 36" X 60" HOISTING ENGINE.
Shows tail-rod and drum.

deflection increase the life of the drum. The spiders are of cast iron in halves secured by keys and by bolts shrunk in place. These are of very massive construction and are secured to the drum segments by fitted bolts in reamed holes. Experience has shown that it is constructionally almost impossible to satisfactorily fit the drum and spiders with cylindrical joints, and all modern drums are made either with planed joints on the polygonal faces of the spiders;—lugs on the drum being planed to coincide with these—or with joints in a plane at right angles to the line of the shaft; the bolt holes in the latter case are drilled and reamed in place. Either of these constructions makes a satisfactory and durable drum, while with cylindrical joints constant breaks of the spider bolts and the use of shims between the spiders and the drum are inevitable.

As a further point in drum construction, pointed out by Mr. Behr (Transactions of the Institution of Mining and Metallurgy, London) deep circumferential ribs are satisfactory; but beware of deep longitudinal ribs; they invariably crack at the line of change from cone to cylinder. Instead use a fillet of ample radius at all re-entrant angles.

For cranks I personally prefer steel castings with cast counter weights; though cast iron balanced wheel cranks are in general use. These may as well be banded with heavy wrought bands shrunk on at first, as this will be done eventually, and it is better to avoid the inevitable cracks in unbanded cranks. The pins are made very large to stand reversing under full steam pressure, and at full speed, and the maximum pressure per square inch of projected section should not exceed 1000 pounds.

All sorts and descriptions of valves are in use in the region. For small and moderate sized engines balanced slide valves are in universal use up to such a size as may be readily reversed by hand. For the larger engines either piston valves or special balanced slide valves are generally used, with a very few corliss valves. The steam and exhaust ports are unusually large to permit at least 1,000 feet per minute piston speed, which with large engines is frequently exceeded. A hoisting speed of 2500 feet per minute in vertical shafts is common.



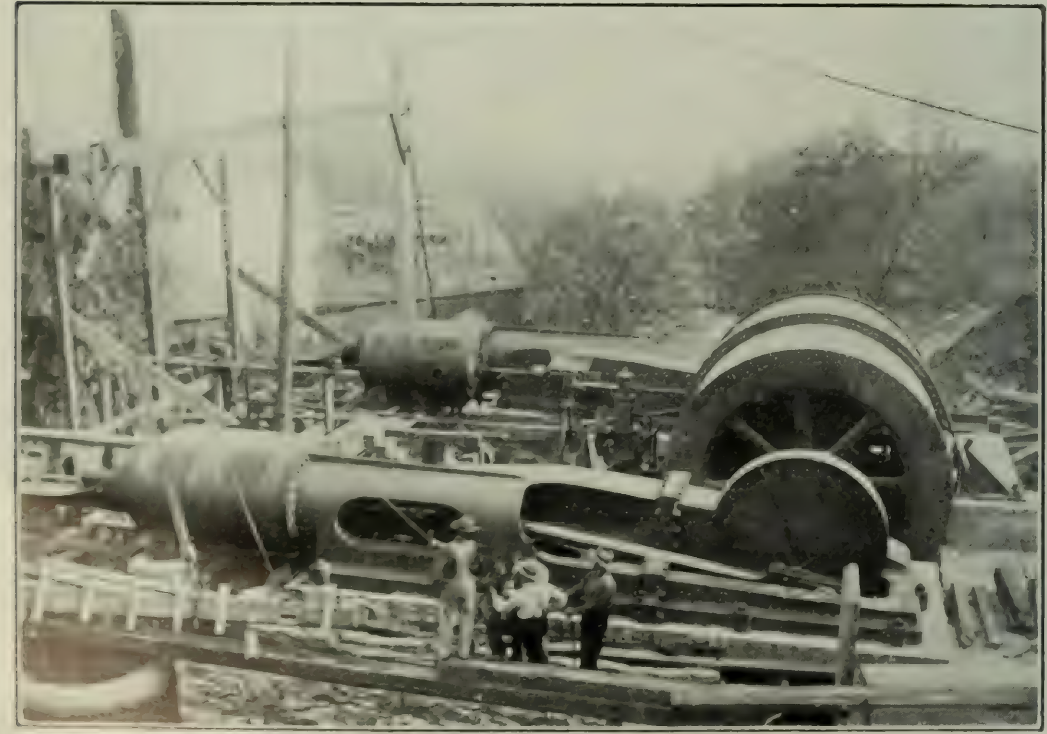
CORLISS HOISTING ENGINES

Coned drums 10 to 14 feet. Built by the Vulcan Iron Works, Wilkes-Barre, Pa., for the Maxwell Shaft of the Lehigh & Wilkes-Barre Coal Co.

and 4000 feet per minute has been maintained in the middle of the hoist in several deep shafts.

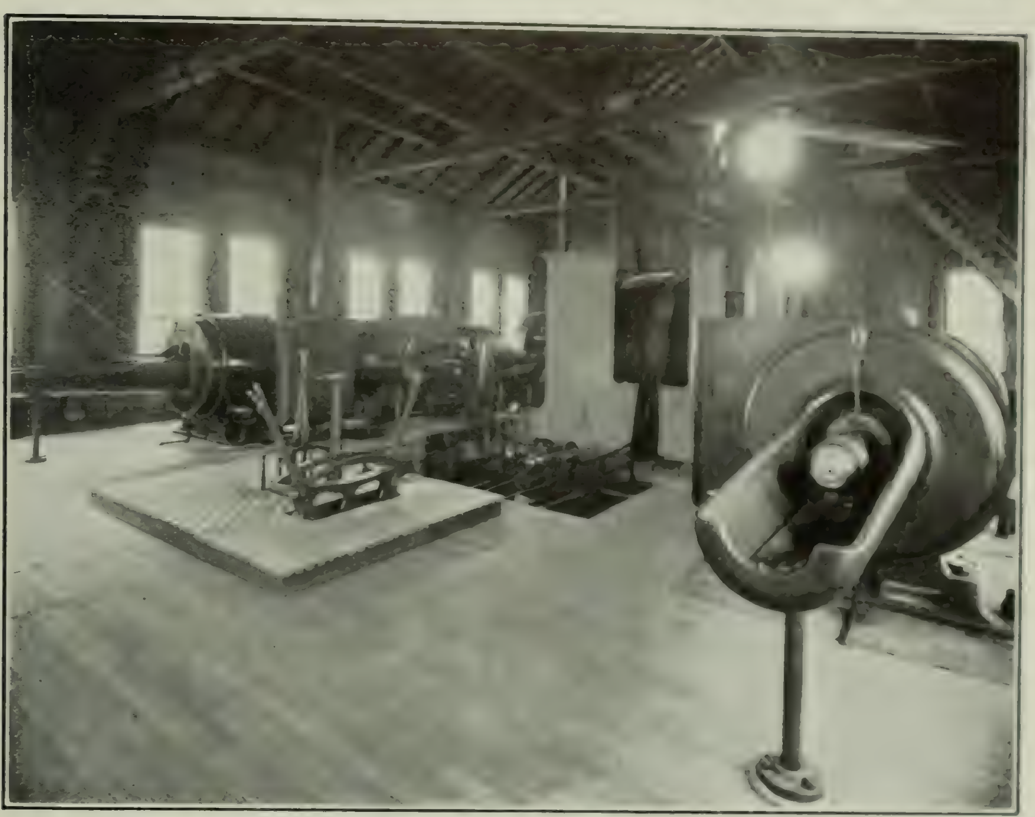
As extremely rapid hoisting and handling is aimed at; steam economy is necessarily a secondary consideration. Typical indicator cards show the steam following about three-quarter stroke. While this is far from economical from the standpoint of steam consumption, the more rapid hoisting often warrants the apparent extravagance, as it does not take very many additional two ton cars of anthracite to pay the entire daily steam expense. It is very easy to cut off the steam in a hoisting engine early enough to materially reduce the daily hoist; and it must always be remembered that, as a rule, the capacity of the colliery is governed by the hoisting and not by the breaker capacity.

The design of engine pistons after many experiments has pretty well settled to a standard of a very light one piece piston with two packing rings sprung into place and steam packed. The face of the piston outside the packing rings is usually turned slightly smaller than the cylinder bore, as a tendency to hug the lower side of the cylinder with full steam pressure on the upper half of the exposed portion of



42″ x 60″ FIRST MOTION HOISTING ENGINES.

Fifteen feet, wood lagged drums. Built by the Vulcan Iron Works, Wilkes-Barre, Pa., U. S. A., for the Lehigh Coal & Navigation Co., Lansford, Pa.

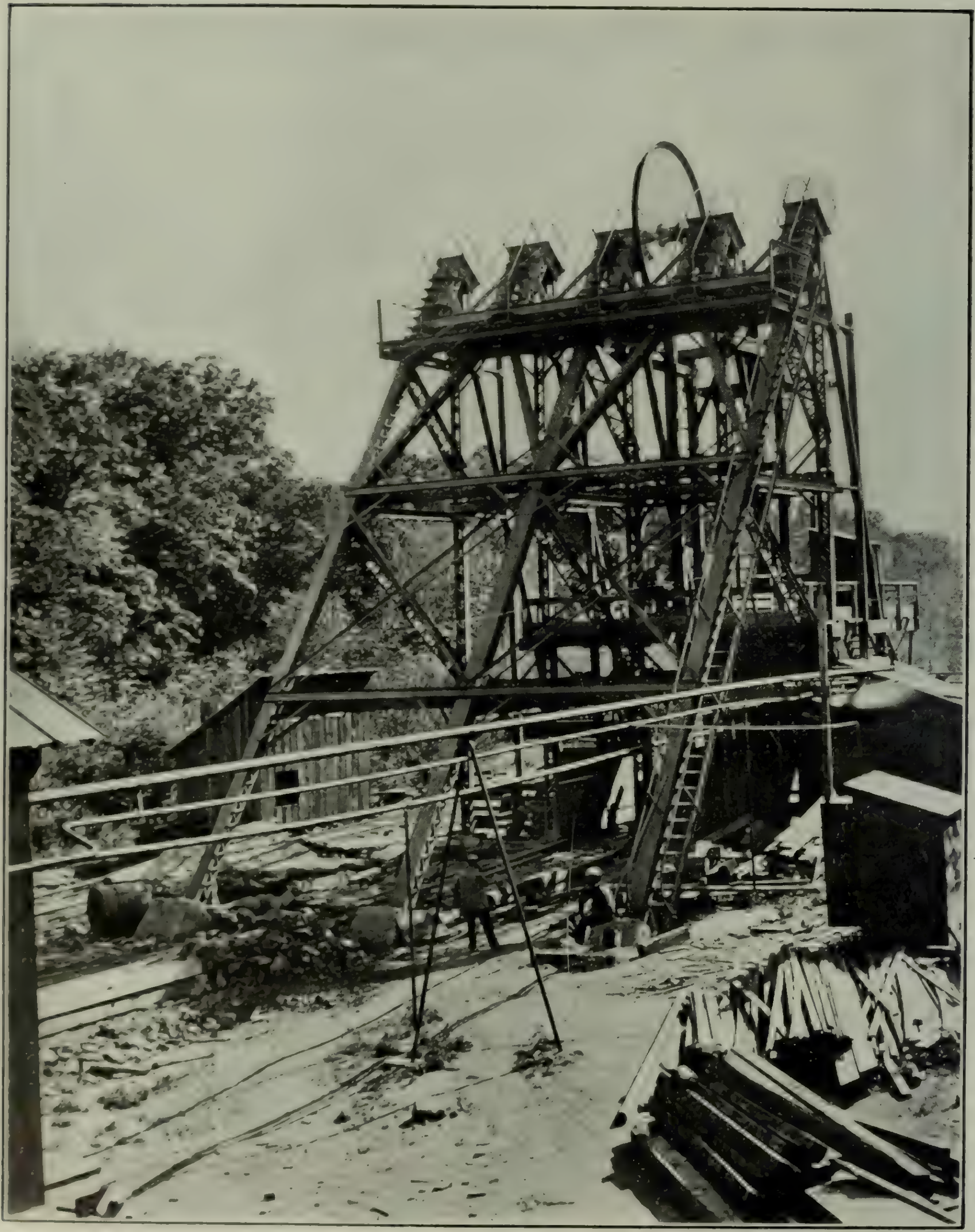


WATER HOISTING ENGINES.

Cylinders, 42" diameter by 60" stroke. Direct acting with balanced slide valves. Double wood lagged drum, 12' 8" diameter, 14' 6" long. Steam brake and steam reverse. Built at the Scranton Works, Scranton, Pa., for Lehigh Coal & Navigation Company. Installed at No. 6 Colliery, Lansford, Pa., by the Allis-Chalmers Co., Milwaukee, Wis.

the piston has often resulted in very rapid wear. Tail rods are used for some of the very large engines, the support being either attached to the rear cylinder head or carried on the foundation. The latter plan has the advantage that with proper design the cylinder head may be removed (sliding out on the tail rod) without much work, and the disadvantage of more difficult and less permanent alignment.

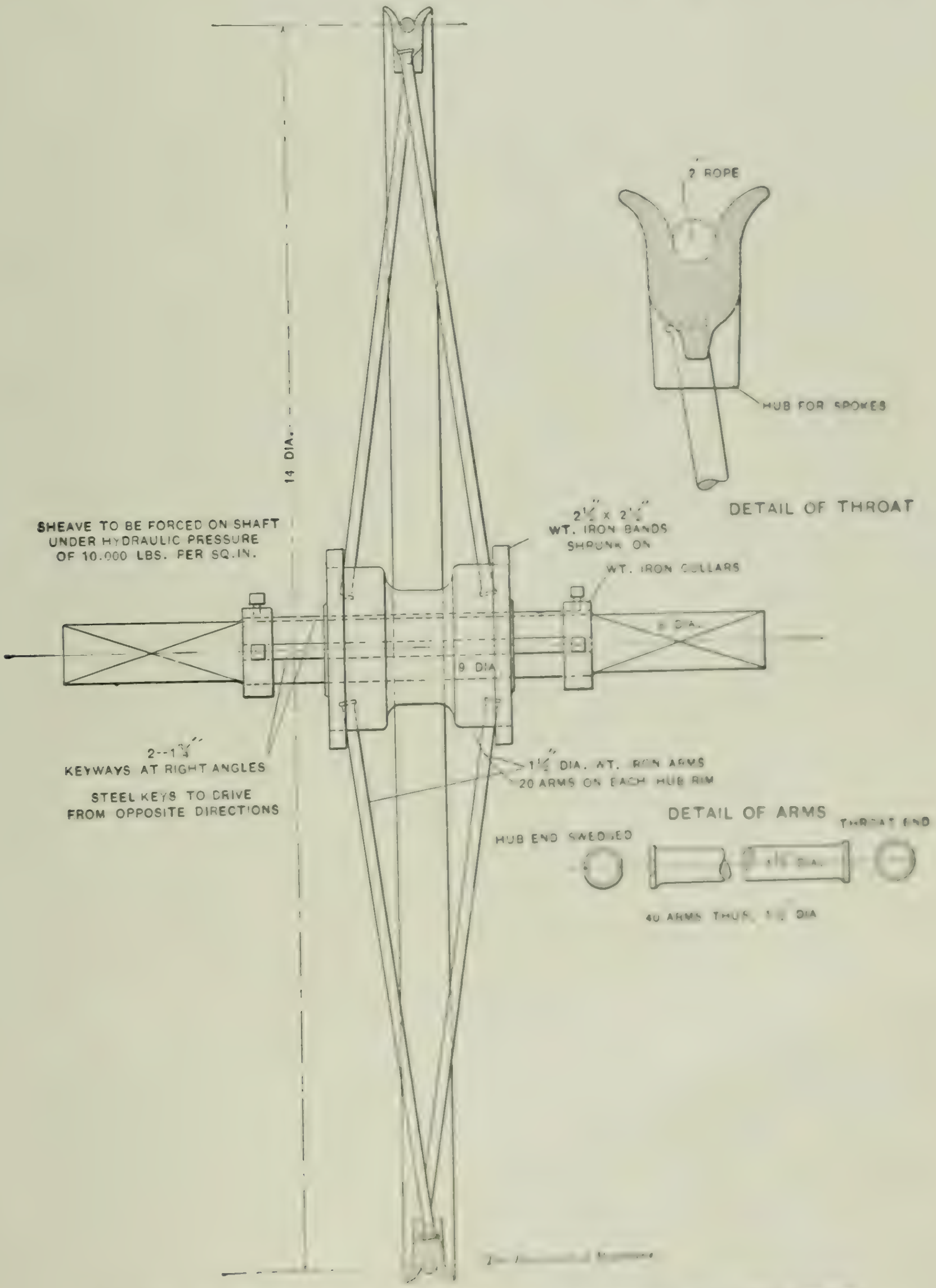
The mining law of the State of Pennsylvania requires "hoisting indicators"; hence all hoisting engineers are supplied with devices to show the position of the cage or car in the shaft or slope. Two general principles are adopted in these, either a disc indicator with revolving hand, actuated by worm or chain from the engine shaft, or vertical indicators in which an indicating finger is hoisted or lowered on a vertical graduated scale. Indicators of the first type are usually supplied with the first motion engines, and of the second type with geared engines; though the type used is largely a matter of the personal equation of the designer, and either is entirely satisfactory.



STEEL HEAD FRAME.

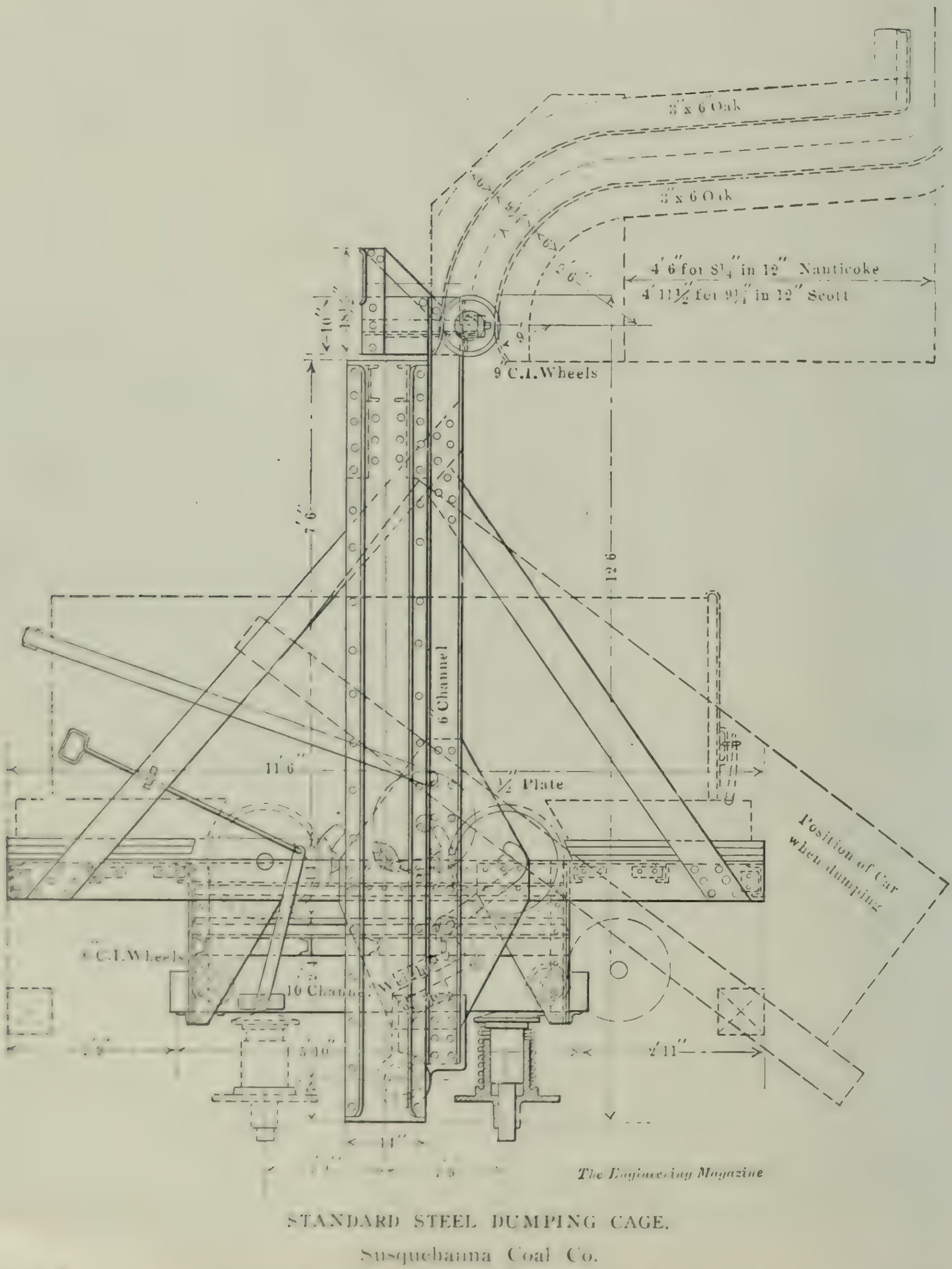
Susquehanna Coal Co., Skarees, Pa.

The reversing of small engines is by the ordinary link motion with a hand lever; but very many of the hoisting engines employed in the region require valves so large that hand reversing is difficult or impossible. Such engines are reversed by enormous links moved by power. The reversing engine employed consists usually of two cylinders, one actuated by steam, the other being an oil cataract cylinder, the two pistons being on the same rod. The slide valve is connected to the steam cylinder valve, and the valve motion is on a floating centre so arranged that the motion of the piston, and hence of the links, follows exactly the motion of the engineers' lever, so



14 DIA.
? ROPE
HUB FOR SPOKES
DETAIL OF THROAT
SHEAVE TO BE FORCED ON SHAFT UNDER HYDRAULIC PRESSURE OF 10.000 LBS. PER SQ.IN.
2½" x 2½" WT. IRON BANDS SHRUNK ON
WT. IRON COLLARS
9 DIA.
9 DIA
2--1¼" KEYWAYS AT RIGHT ANGLES
STEEL KEYS TO DRIVE FROM OPPOSITE DIRECTIONS
1½" DIA. WT. IRON ARMS
20 ARMS ON EACH HUB RIM
DETAIL OF ARMS
HUB END SWEDGED
THROAT END
1½ DIA.
40 ARMS THUS, 1½ DIA

SHEAVES, 14 FT. SUSQUEHANNA COAL CO. STANDARD WROUGHT SPOKE.

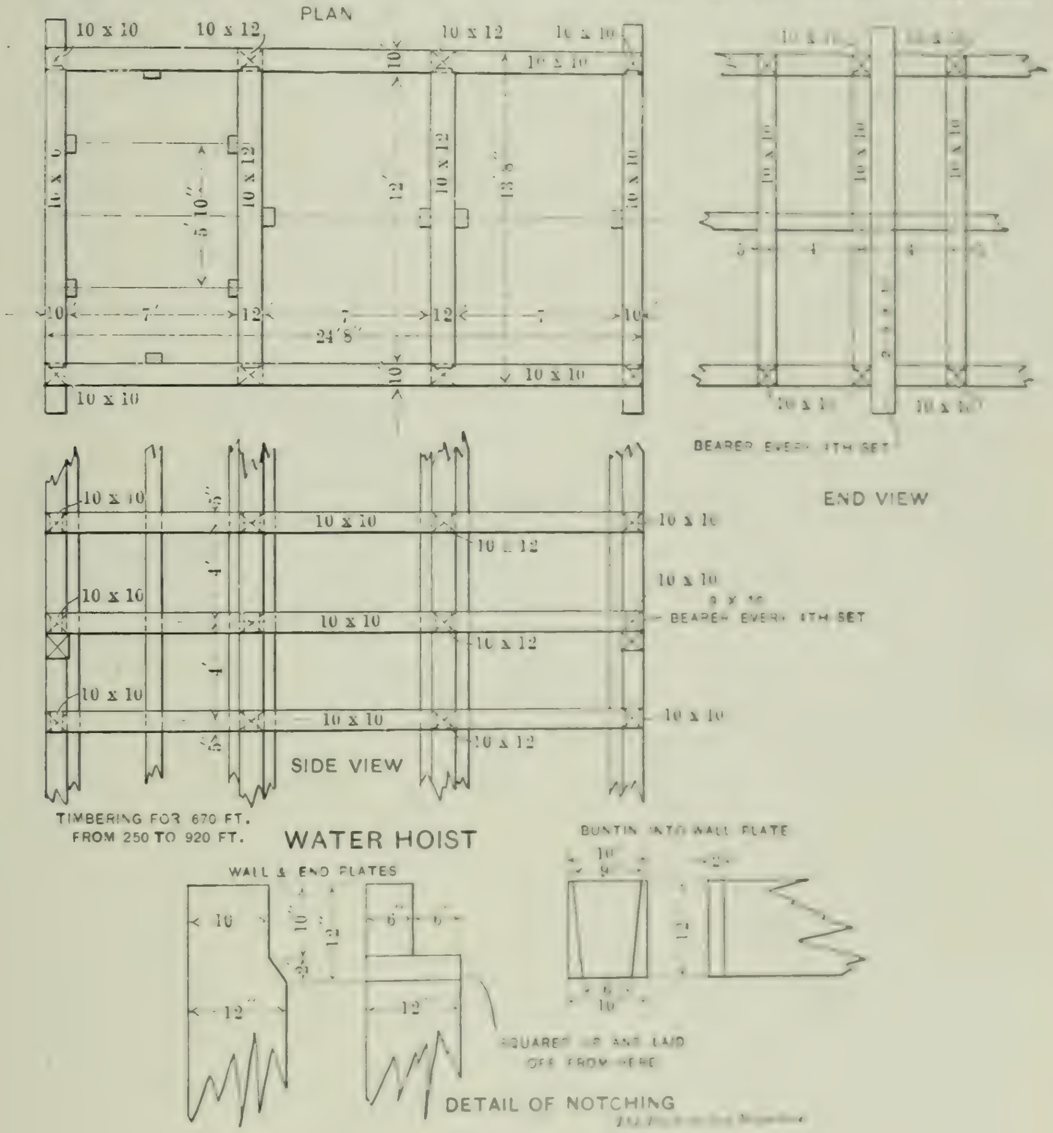


STANDARD STEEL DUMPING CAGE.

Susquehanna Coal Co.

that he can readily and positively set and lock the links in any desired position. The generally accepted plan is shown in the photographs.

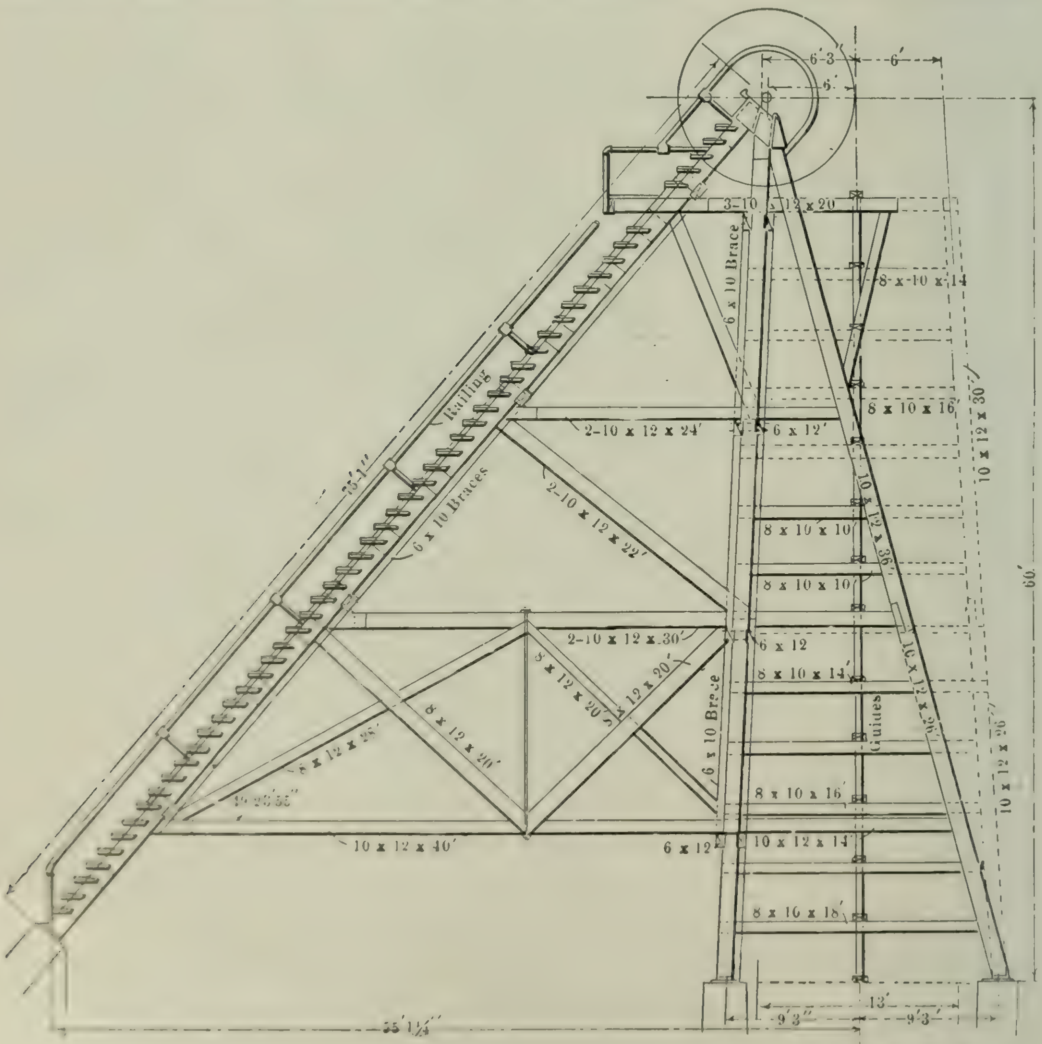
Of as much importance as the engines to rapid and economical hoisting, is the detail construction of the shaft, guides, head frame and sheaves. Taking these in their order, the shafts are generally timbered throughout. The timbering consists of square sets at intervals approximating four feet. These sets comprise the side and end plates and buntons separating the hoistways. In loose ground 2" to 3" planks are placed outside the timbers all around the shaft, with any blocking necessary to support the ground. The sizes of timber used depend on the conditions, the depth and importance of the shaft. The sets are separated by posts at the corners and under each buntin. At intervals depending on the local conditions, bearers are inserted supported in notches in the rock. During sinking the timbering is started from the surface, stopping from time to time, and resting on these bearers as the sinking progresses, and always kept enough above the bottom to avoid or minimize damage from blasting.



TIMBERING.

Scott Shaft, Union Collieries, S. C. Co.

Timber guides, secured to the end timbers and buntins are used exclusively; these are generally about 6" x 8", though 8" x 12" have been used in several of the most recent deep water hoisting shafts, as it has been found that the 6″ x 8″ guides are rather light for the excessive loads and high speeds involved in hoisting water. The vertical guide timbers are secured to the shaft timbering in various ways, depending upon the conditions and more upon the personal equation of the operators. Generally the guides are secured by lag screws, one or two to each buntin. These lag screws are, or should be, so constructed that the solid round shank extends into the buntin, the threaded portion, with cone drive threads being entirely in the buntin. This construction has the advantage that acid water acts on the full section of the rod—not on the threaded portion. Another construction in vogue has castings bolted to the buntins, to which castings the guides are bolted with the nuts inside, this materially saves the

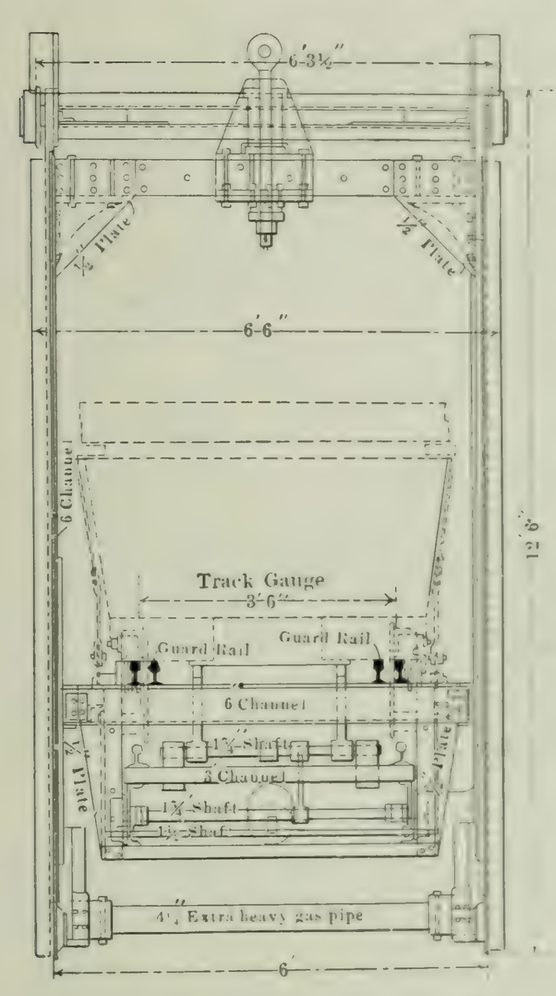


The Engineering Magazine

HEAD FRAME.

William Penn Colliery, Susquehanna Coal Co., Wilkes-Barre, Pa.

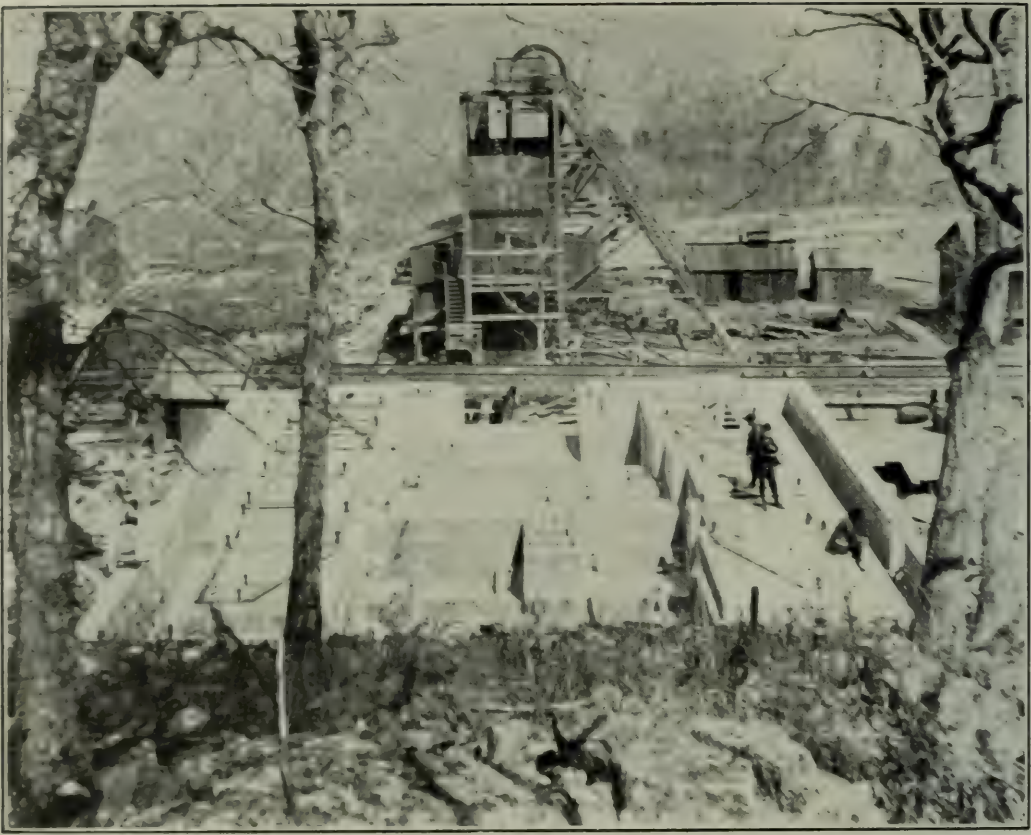
buntins; but the nuts usually rust fast and must be cut off the bolts. A third system splices the guides with blocks just above the buntins, the bolts passing through the two guides in adjoining compartments—a very strong construction with the disadvantage of laying both the compartments idle for repairs to guides in one.



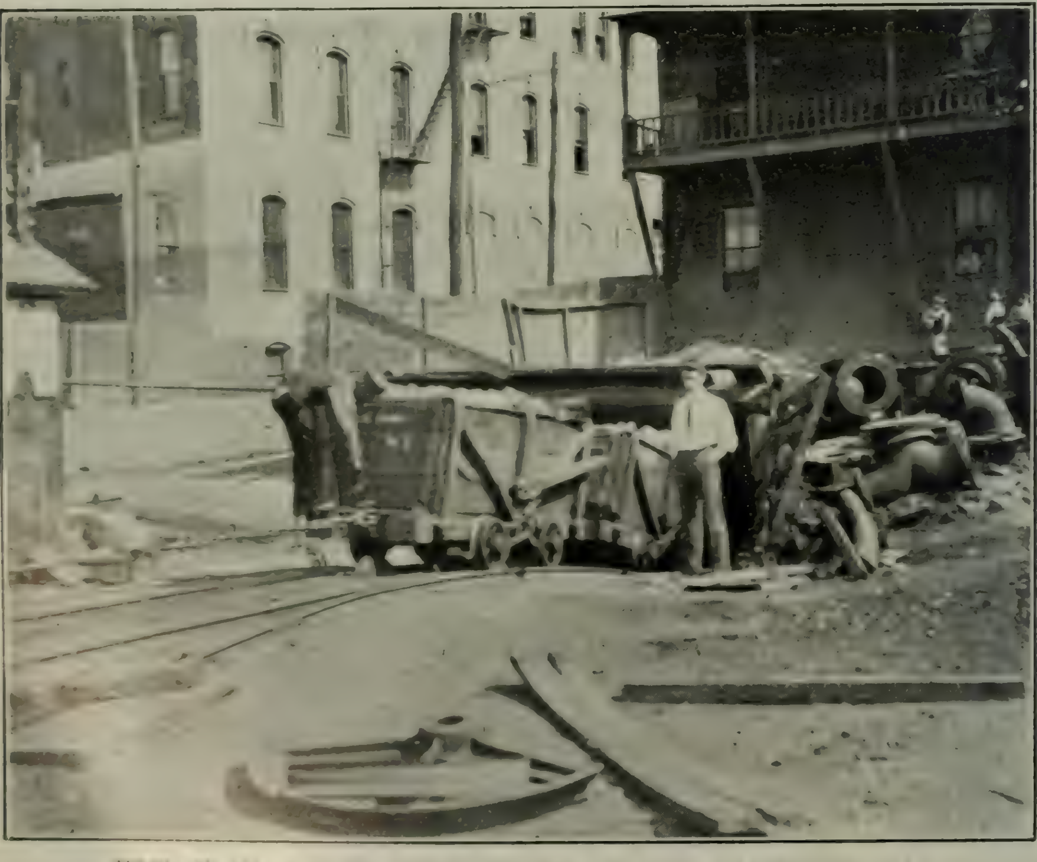
STANDARD WOOD AND IRON CAGE.
Lehigh Valley Coal Co.

Shaft cages are invariably single deck, in contradistinction to the multiple deck cages used in other countries and in metal mining. As the loaded mine cars weigh from 6,000 to 10,000 pounds, one at a time is enough to hoist. The cages are generally of composite construction with steel plate angle guides and timber platform. All wood and all steel cages are, however, largely used. Cages are provided, as required by the State law, with hoods to protect the men, and with safety devices to catch the cages in the event of the breakage of the hoisting rope. That these safety devices are efficient is evinced by the very small percentage of failures in the recent severe and exhaustive tests made throughout the region by the mine inspectors, as the result of a single and unusual accident. Dumping cages are in limited use, generally in "breaker towers" from the surface to the tops of the breakers, though used in a few cases from the mines; these automatically dump the car without removing it from the cage, and materially reduce the time of handling, but they are only available in the few cases where shaft hoists can dump directly into the breaker or into conveyors tributary thereto.

The head frame erected over the shaft is of no small importance. In the general scheme of modern hoisting, the conditions to be filled are ample height and strength, and freedom from disaster. As to the

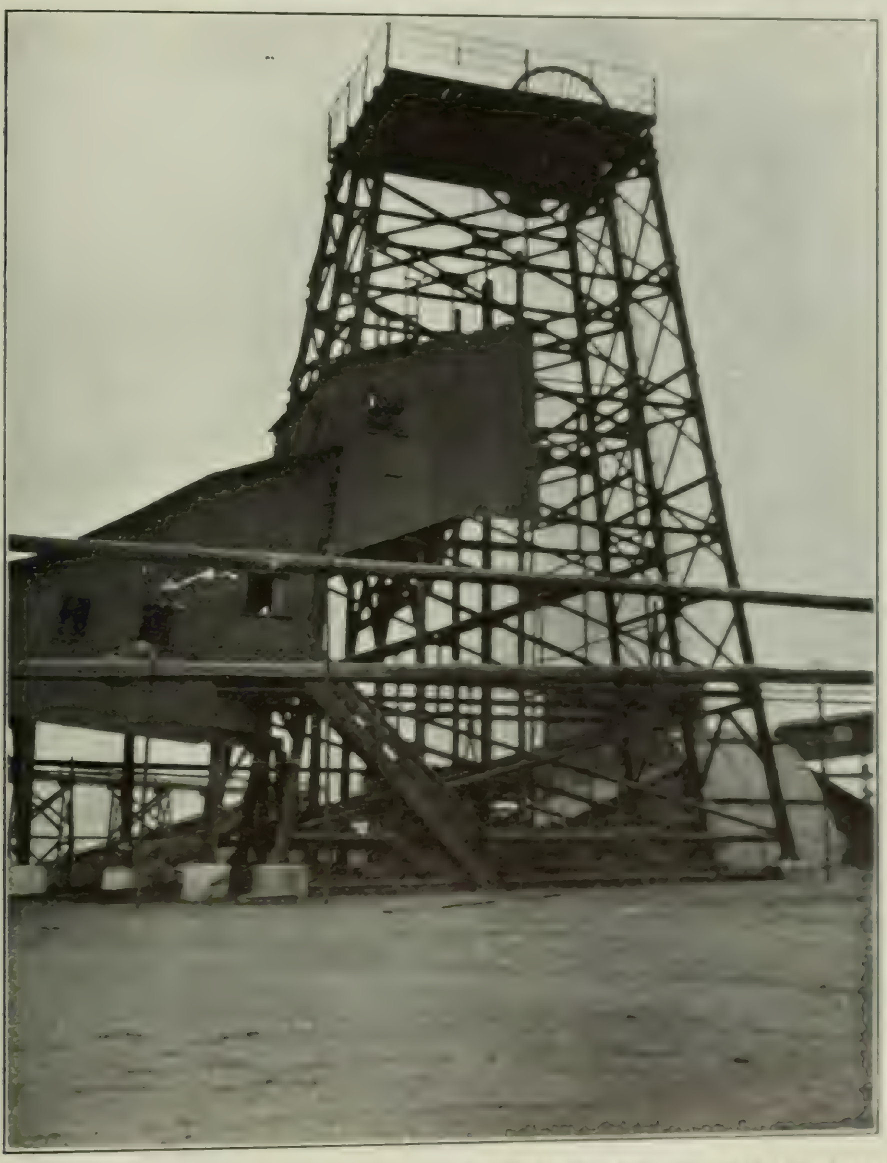


CONCRETE FOUNDATIONS FOR PAIR OF 36″ x 60″ FIRST MOTION HOISTING ENGINES.
Bear Valley, No. 2 Shaft, Summit Branch Mining Co.



HEAD OF NO. 4 SLOPE, SUSQUEHANNA COAL CO., NANTICOKE, PA.
Slope [illegible] feet long, 5° to 20° pitch pair 26″ x 60″ first motion engines.
Hoist, four mine cars per trip.

first, the height from the landing to the centre of the sheave has in the last few years, increased from the earlier heights of 20 to 30 feet, to from 50 to 60 feet, in the most modern frames. The increase is demanded by the great increase in speed and the consequent margin required for stopping in the modern engines. Head frames are usually constructed of timber, though steel construction is coming rapidly into use. Three general types are in use. The triangular frame is entirely clear of the shaft, which permits of an overwind with merely the wrecking of the sheave as a penalty, as no part of the frame proper is in the line of the hoist; the only parts of the structure over the shaft are the guide supports. The second type carries the sheaves



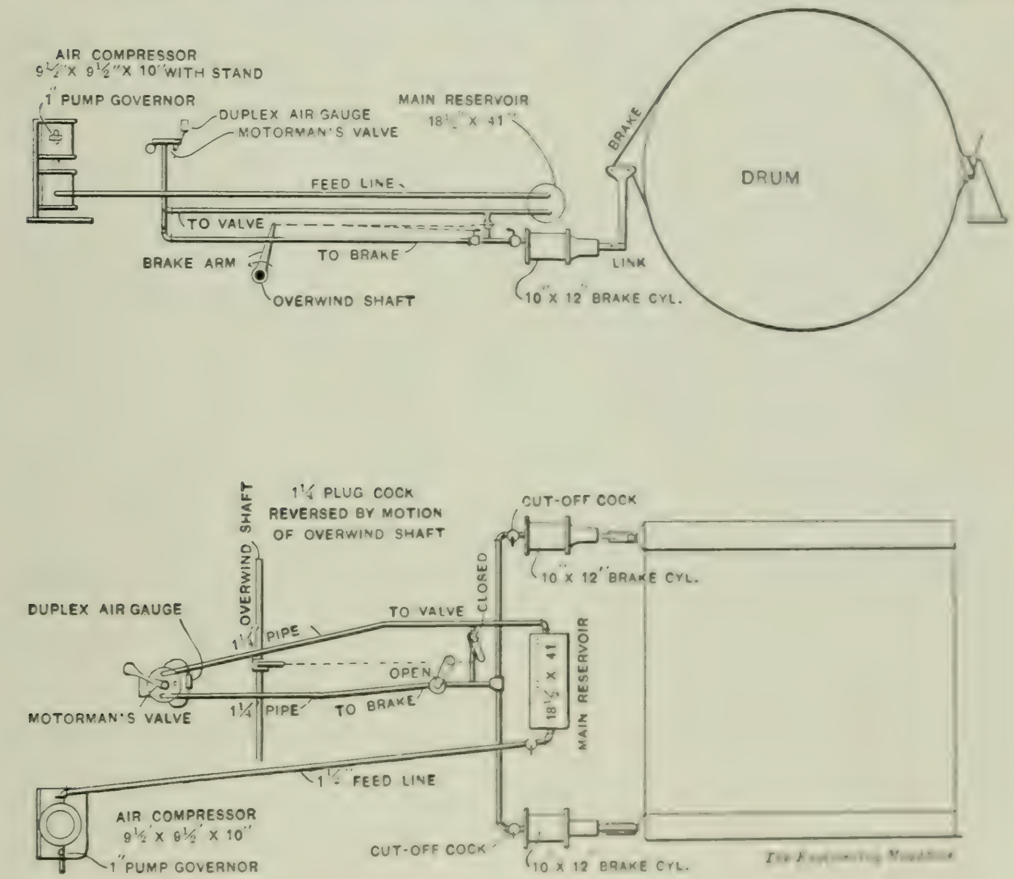
STEEL HEAD FRAME. PROSPECT SHAFT, LEHIGH VALLEY COAL CO., WILKES-BARRE, PA.

on a truss over the frame. This is somewhat lighter than the first type, as the guides are carried by the frame proper; but it has the disadvantage that an overwind will do material damage to the frame itself. The third type has a tension member, it is lighter and lower in first cost than either of the others, but it is more likely to be totally wrecked by an over-wind.

SHAFT CAGES.

Susquehanna Coal Company, Susquehanna, Pa.

The head frame sheaves are usually of the wrought spoke type. These sheaves should be in any event as large in diameter as the drum of the hoisting engine, while many of the larger operators use a sheave even larger than the largest drum as a standard. The earlier sheaves were constructed with wrought arms cast into the rim and hub, the connection being made by grooving the arms, this construction, while satisfactory for light duty, failed by the breaking of the wrought arms in the grooves. This was overcome by upsetting the ends of the arms and casting them into the hub and rim without reduction of area. Shaft sheaves must be turned true in the grooves as a very small eccentricity results in disastrous vibration of the ropes. A later type takes cognizance of the wear of the rim, and the sheave is constructed with a replacable rim. While this sheave is materially higher in first cost than the usual type, it can be repaired by renewing the rim, while sheaves of the ordinary type are valuable only as scrap when the rim is worn out.



AIR BRAKE.
Susquehanna Coal Company Standard.

In general, while the hoisting practice is perhaps not up to the most modern practice in steam economy, in speed and in quantity handled it defies competition.

To most men—such as are even engaged in other lines of engineering construction—the mechanical details of mine hoisting cannot fail to be of interest. It is here shown that they are vital to the success of the majority of coal-mining industries.

With many, the mining of coal is classed among the roughest kind of mechanical operations, in which the pick, drill, and mule-car play the most prominent part—an idea which has survived he era of primitive mining operations. Modern mining, however, has been brought to a state of engineering refinement never dreamed of by pioneers of the industry.

To the lay reader the condensed presentation of the state of the art as now conducted, even so far as it relates to the lifting of coal from its normal level to the surface, will be a revelation such, as without expert instruction, could not be gained even by a tour of inspection throughout the anthracite districts.

The manner of obtaining the great supply of fuel, which is so intimately related to the progress of civilization, of which supply Pennsylvania anthracite regions are one of the most important sources of supply, will ever continue to possess an interest superior to that of many industries to which coal-getting is commercially vital.

The facts given illustrate the importance of skillful engineering to mine hoisting, and serve to place in a strong light the great advancement made during the last twenty-five years by careful study and construction. It will be seen that even the smallest details have received attention, and that what might seem of small moment to those unfamiliar with the requirements of coal-hoisting prove upon examination to be far otherwise.

It has been the endeavor to present these details of construction in a concise, yet comprehensive manner, and, at the same time, to enunciate so clearly the objects sought to be attained in each of these details that they will be readily understood by ordinary readers as well as technically-trained engineers.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker and Walter Brown.

I. THE PROBLEM STATED.

This article is the inaugural of a series giving the conclusions of a most valuable practical study of the use of high-speed steel, made in one of the largest American machine shops. The succeeding numbers will set forth the results found under working conditions, pointing out the factors to be considered; the mode of determining when and where to introduce high-speed steel; the advantages and disadvantages of rough forging and large chips as compared with close forging; the handling of steel in the making of tools.—forging, tempering, and annealing; grinding and setting of the tool, and the proper relation of tool and work; relative cost of carbon and alloy steel tools, and the quality of work turned out; new machine requirements, speeds and feeds, and the adaptability of alloy-steel tools to different kinds of work, as well as the jobs to which it is not adapted. It will constitute a complete review of the subject.—The Editors.

MANUFACTURING in the metal trades still lacks much of being revolutionized by the new tool steels with their remarkable properties, as was enthusiastically predicted upon their first appearance as a commercial product. Revolutions do not come so suddenly in industry. It were better to say that they do not come at all, for industrial progress is evolutionary and not at all revolutionary. A new invention does not upset prevailing conditions, but gradually takes its proper place as an economic factor while still being developed to its highest possibilities. And so the new alloy steels, though their capabilities have been by no means definitely determined as yet, are simply taking their place in production engineering while they are still in course of development. In time we may well expect to see marked changes in manufacturing practice growing out of the new conditions which the new tools must inevitably impose. The changes already effected or in sight certainly give promise of still greater things. The promise is all the more likely to be fulfilled because the alloy steels are merely at the beginning of their development.

Compared with previous experience, some of the showings that have been made are nothing short of marvellous. Especially is this true in certain cases where tests have been made under very favorable circumstances to determine the limits to which these tools could be made to do efficient work. Under ordinary shop conditions and on actual work the showings have been less startling. The ordinary shop conditions, however, are not as yet those that would be expected to develop cutting possibilities to the full; for present machine installations, designed as they are to meet requirements of the old *regime,* do not permit reaching anything near the limit of performance of the new tools. With machine design keeping pace with the development of cutting tools, however, and a better understanding of the properties and behavior of the alloy steels, there is a corresponding increase in efficiency; so that the performances of carbon tools are by comparison very unsatisfactory and often ridiculous. It does not on that account necessarily follow that this indicates the displacement altogether of carbon steel as a material for cutting tools. There are conditions under which a carbon tool will be as efficient as any other could be, and indeed it is a question if for some classes of work it be not much better than one of high-speed steel.

Beyond question the rapid-cutting steels possess qualities making them very desirable in tools; but that is a thing quite different from a demonstration that their use would in all cases be desirable or profitable; for after all is said and done, the question of using the new steels in a shop is mainly a question of their profitableness. If, all things considered, the output is produced cheaper or better than by ordinary tools, then the old order must give way to the new. Nor can the question be decided one way or the other for a whole factory or shop. Its determination is not general, but specific; not for all jobs in general, but for each job in particular. If it were merely a matter of increased output or lengthened life of the tool, there would be no question at all. There are, however, other factors to be taken into consideration, chief among which is the nature of the job itself. For instance, in a job requiring relatively little time for cutting, compared with that used for preparing and setting, there is likely to be little immediate saving, if indeed the increased cost of the tool does not entirely offset the advantage gained. The saving, if any, in such case would be in the time saved in grinding and setting tools. Again, the job may be of such a nature as to make it difficult to hold the piece rigidly enough, or the material may be in such form as to cause many pieces to be inaccurately machined or even broken. A high-speed steel tool is often the thing that will obviate the scrapping of many pieces, and thus produces a saving that may not appear in the piece-work prices at all, where we usually look for a reduction of cost. Furthermore, in short cuts the working time may be so reduced as to become negligible. The common practice of giving two machines to each man presumes that the cutting time is practically equal to the time necessary for handling and setting. If the cutting time can be so reduced as to make it of little consequence compared with the time for handling, there is no necessity for a second machine. There is then a saving in floor space, and the second machine becomes available for other work or for disposal, reducing the item of capital invested on that job and the related item of depreciation and repairs. Such a case of course assumes the use of equipment already installed. The scrapping of expensive machinery to make way for other of improved design has been practiced to advantage, no doubt, in some well advertised instances, and very likely in many others that have not attained publicity. The present practice in production engineering seems inclined toward the less radical course of utilizing, so far as possible, equipment already installed, adapting it to the greatest possible extent to the new requirements where this may be done without prohibitive outlay, and then getting out of the machinery all there is in it in the shortest possible time, scrapping it when worn out.

The problem is, then, chiefly one of utilizing existing installations. The extent to which this can be done with profit necessarily depends largely upon the capabilities of those machines and the class of work required of them. In general, it may be said that most machines now in use are capable of being speeded up considerably beyond what would usually be practicable with carbon tools—on small jobs at any rate. If the bed be rigid enough, they may be speeded up to the limit of a high-speed tool even. But an increase in speed necessitates an increase in the power required for driving. As ordinarily designed, machines have cone pulleys with face sufficient for the former requirements only, and it is necessary to make provision for the application of the necessary additional power. This can usually be done by substituting cone pulleys of fewer steps and wider faces. There is another limitation to the speed of a machine so adapted, namely the strength and rigidity of the frame or bed. Running at very high speeds there will be more or less vibration and in consequence inaccurate work, saying nothing of the excessive wear on the running parts

The speed, or rather the extreme lack of it, at which much of the work under the old conditions was (and often still is) done, is distressing to an observer in thorough sympathy with the spirit of this age. He likes to see movement—quick movement—every moment of time and every expenditure of energy counting for the utmost possible. To see a large piece of metal lazily creeping round and round, the tool paring it down at a snail's rate, is enough to set his teeth on edge because it is so wasteful and unnecessary. Of course the expedition with which wood and similar unresisting materials are worked up is not for metals. At least not yet. Whether in the future metal-cutting tools and appliances will be perfected sufficiently to make possible the working of iron and steel with as much ease as we cut cheese, remains to be seen. The high-speed steels appear to point in that direction; and there does not seem to be any inherently unsurmountable obstacle to the ultimate attainment of so desirable a consummation, distant though it may now be.

Under the old *regime* the limit of possibilities in the cutting tools were reached at relatively low speeds. Twenty feet was about an average, though indeed there were notable exceptions that promised important advancement in the art of rapid cutting of metals. The highest speed successfully attained, so far as shown, was about 100 feet per minute; and this was under the most favorable conditions of lubrication, cooling, and chip removal. The conditions, however, involved a complicated system of appliances that could scarcely be adapted to ordinary work, and that would be so expensive to operate as to be prohibitive; so that a speed half as great may be considered the limit as attained with carbon tools—a limit reached only under conditions not ordinarily found. The advent of self-hardening steels permitted a distinct increase in speeds; but nothing like what is now possible with alloy steels. Since the commercial development of the Taylor-White discoveries, nothing short of bad management would permit the waste of time that used to accompany the taking of long cuts on large pieces. Evidently the day is about past when a workman can or must put in hours at a time idly lounging near his machine, merely keeping an eye on the work to be sure everything is going well, while the machine indolently pares down the piece to the required size and shape. In the machining of such pieces high-speed steel tools fill a long felt want.

In operations upon small pieces reduplicated in large numbers, especially if there is but little machining to be done, as already pointed out the need for increased speed is less evident. The limit of the operator's endurance, and therefore the limit of output, has usually been reached in these cases. The exceptions are those parts produced, or susceptible of production, by automatic and semi-automatic machines requiring little attention and skill in the operator or attendant. The evident lesson here is the same whether viewed from the economic or sociological point of view, namely the development and multiplication of automatic machinery. The sociological aspect of the problem—that is, the influence upon the operator of the deadening monotony involved in feeding stock into and practically becoming part of a machine—is one that must be met in the near future anyway. With the development of high-speed steel tools and machines to use them, the problem (a problem many an employer does not yet know to exist) will become more insistent for solution. The automatic machine seems at present to be the only solution in sight; and the high-speed tool with its lasting qualities is one of the most important features of the future automatic machine.

A serious difficulty in many shops is that of overcoming the lack of uniformity in the hardness of pieces to be machined. Every shop at some time or other has this experience. Gray-iron castings sometimes come so hard that the tools in use, even if of self-hardening steel, make a poor showing indeed. Only a few pieces can be finished without re-grinding and re-setting the tool. The same thing sometimes happens in finishing steel rods and similar parts. An extreme case in point that came under observation was that wherein a shaft regularly made of hard and tough steel at times came so hard that often it was impossible to finish a single piece at a grinding of the tool. More time was used in grinding the tool than in cutting metal. Less extreme cases are common enough. Before the time of alloy steel the working up of such pieces was almost out of the question. A high-speed tool does not balk at hard stock. It cuts both hard and soft indifferently, and if properly treated is about as little affected by one as by the other. The treatment of the tool must, however, be different. In the case above referred to the high-speed tool with which the self hardening one was replaced finished a hundred or more before requiring re-dressing.

The problem of lubrication and cooling, frequently a most difficult one to work out satisfactorily, becomes no problem at all when attacked from the rapid-cutting-tool side. Such a tool ordinarily requires neither cooling nor lubrication. It is true that if used at extreme speeds it is of advantage to keep down the temperature of the tool, as it will require fewer dressings. It may seem absurd to suggest keeping the cutting edge of a tool below a red heat; nevertheless it is actually true that certain high-speed tools often do good work at high temperatures, and have been found efficient when working even just below a red heat that is barely perceptible in daylight. Such a temperature however approaches the critical limit, and at a red heat most tools quickly break down.

The lubricating fluid, preferably soda or soap water, is undoubtedly useful also in helping to carry away the chips in some cases, and possibly prolongs the life of the tool somewhat. But it may well be doubted if these advantages are sufficient compensation for the inconvenience and expense of a lubricating system, except in instances where it is necessary to cool the piece machined because of its small size and consequent inability to conduct away the heat generated in cutting. In such case it may be necessary to cool the piece to prevent warping and distortion.

There has been a good deal said lately as to whether or not high-speed tools can be used to advantage in finishing cuts. A tool of this sort cuts in a manner entirely different from that of a carbon tool. The latter has a true cutting action; but the former tears off the metal more after the manner of a wedge. The peculiar action of the alloy-steel tool is in part due to its granular structure, which prevents it's holding a sharp and clean cutting edge when in use, as the carbon tool does. In consequence the work done is likely to be rougher than if cut by the latter. Since their first appearance there has been a marked improvement in respect to their ability to cut smoothly and accurately. Such steel can now be had of a texture sufficiently smooth to permit its holding a sharp edge, so that proper treatment and dressing, and a correct relationship of tool and work, will make it possible to do quite accurate finishing with high-speed tools. In general, however, their highest efficiency is in taking roughing cuts or in doing work where extreme accuracy is not required.

When first put on the market the alloy steels were not well adapted to cutting gray iron; and their efficiency in this respect is still below what it is when cutting steel. That is, equally high speeds are not as yet found practicable, though there is no doubt that important economies can be effected in machining gray iron as well as steel. With respect to brass, however, the question is still open to discussion. The savings, if any, are usually small, and are due mainly to the one item of less frequent dressing of the tool.

The final factor in the problem is that of intelligent making and handling of the tools. In a large plant manufacturing its own tools the factor is more important than in a small one buying its tools ready made. Properly treated high-speed tools may now be bought in any form and to meet practically all requirements, so that it remains only to consider the proper grinding and setting of the new tools. This is merely a matter of educating the operatives, and might be done by an expert temporarily employed for that purpose. Manufacturers of high speed steels furnish printed instructions for the handling and use of their particular product. Such instruction is of course useful, but falls a good deal short of personal instruction and experience; and where it is at all possible to obtain it, such instruction is bought cheaply, even at a high price. In the large plant it is important to have a man in charge of the whole situation who is competent to get results—a man who can himself, if necessary, take a piece of steel, make it up into a tool, and set it at work properly, in addition to being able to determine when and where to use it. Of course, a man lacking some of these qualifications could be of great service, and might develop himself so as to be able to handle the whole situation in time.

The subject of alloy-steel tools, both in respect to their production and practical use, is of serious importance to the metal-manufacturing trades. As yet the subject has been scarcely more than approached, and in the nature of things there can be no definite reduction of practice to recognized standards until there shall be considerable additions to our present experience and knowledge.

It is hoped, however, that the present series of papers will be useful to the extent of bringing together such experiences as may have been found to indicate the probable direction in which standards of practice may ultimately be found to lie.

Summing up the whole situation as it confronts the factory manager, it may be stated about thus:—

Given an equipment reasonably well adapted to the work required and doing it satisfactorily under conditions previously prevailing: What can be done with it in using high-speed steel tools? High-speed tools undoubtedly make possible, in most cases, a distinct reduction in the cost of production; but in order to secure the full advantage—that is, to work them to the limit of efficiency—heavier machinery is required, designed to meet the new conditions. Is it necessary to incur this great expense, or can the present equipment be adapted to permit a profitable substitution of the new tools? Undoubtedly the second course is preferable, except in possible specific instances. The savings will not be so great, in general; but usually it will be the more economical course to use existing installations, adapted so far as possible, until worn out.

Second, shall carbon tools be at once and entirely replaced by those made of alloy steel? By no means. In many cases doubtless it will be necessary to continue the use of carbon-steel tools, for reasons that will appear in the specific cases. Furthermore, time will be required to find just where the new tools will be of advantage, and to determine just the conditions under which the tool must work in order to get the best results. The change will therefore be a gradual process, each case being considered upon its own merits.

Third, there are certain classes of jobs that can advantageously be taken up first. The most obvious are those where the present working speed seems unprofitably slow, especially large pieces requiring considerable machinery; where the material is so refractory as to wear out the tool quickly; and where an increased speed will permit reduction in the number of machines needed for the work.

And finally, there is the question of getting the new tools started in the factory and the operatives educated to their efficient use. For this an expert ought to be called into service. The novice may be able to make some showing: but in making a change, economy is the thing under consideration, and it is poor economy to buy such experience at so high a price.

COST KEEPING IN CONSTRUCTION AND CONTRACT WORK.

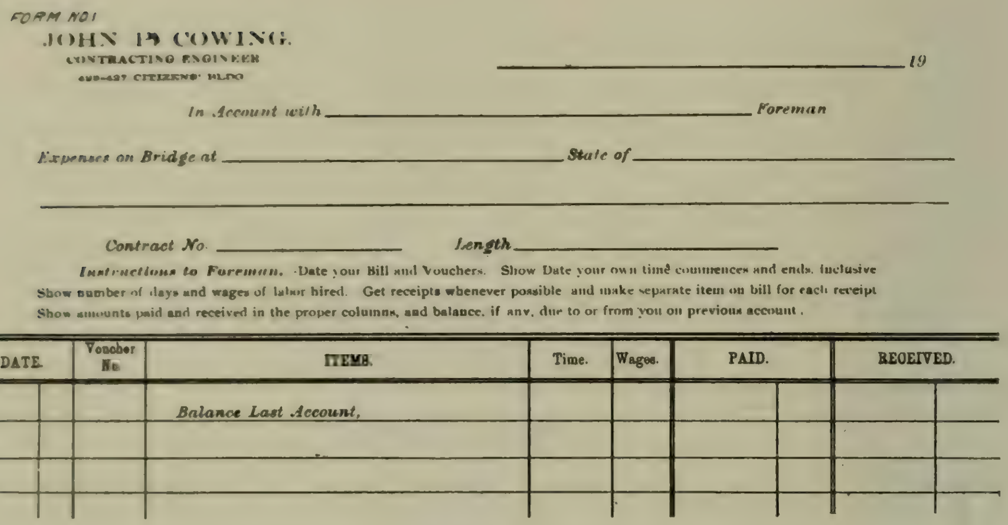
By John P. Cowing.

THE following system of cost keeping in contract work is the result of gradual development in the writer's own work, and is intended to illustrate a good method for keeping the cost of contract work in the main office, which may be hundreds of miles away from the scene of operations. It is a system of daily reports, containing all information necessary to enable the general bookkeeper to keep the cost record up to date with all expenditures properly classified.

The forms illustrated are used in the building of bridges. They can be adapted to any kind of contract work by having the proper kind of work printed under that heading in the first column. This system is accurate and is designed to be kept by the superintendent and cashier in the field, furnishing to the general office each day, not only an account of the previous day's work and expenses, but a summary of the cost of the work, the quantity of work performed each day, the estimated balance of work of each kind yet to be performed, and last but most important, the cost per unit of each kind of work.

Upon receipt of a set of these daily reports, the executive head having the work in charge can tell by a glance at reports, forms No. 5 and No. 6, just what progress is being made, and whether any criticisms or suggestions are necessary to expedite the work or lessen the cost.

My organization and management of a field office is as follows First, when I am ready to commence work in the field on a contract, I build or rent a small building to serve as an office and tool room. This office is in charge of the superintendent of the work, who is directly responsible to me. A bank account is opened in a local bank in my name, of sufficient size to meet one week's pay roll expense,



FORM NO 1

JOHN P. COWING.
CONTRACTING ENGINEER
4[illegible]-427 CITIZENS' BLDG

__________ 19

In Account with __________ *Foreman*

Expenses on Bridge at __________ *State of* __________

Contract No. __________ *Length* __________

Instructions to Foreman. Date your Bill and Vouchers. Show Date your own time commences and ends, inclusive. Show number of days and wages of labor hired. Get receipts whenever possible and make separate item on bill for each receipt. Show amounts paid and received in the proper columns, and balance, if any, due to or from you on previous account.

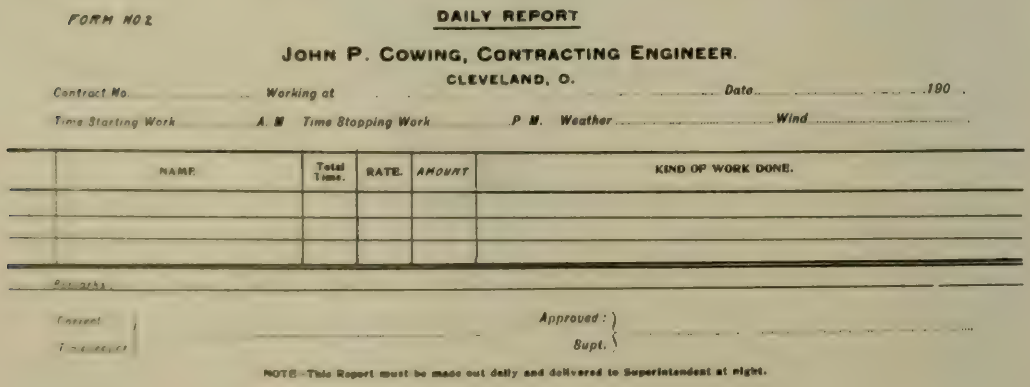
DATE.		Voucher No.	ITEMS.	Time.	Wages.	PAID.		RECEIVED.	
			Balance Last Account,						

DAILY STATEMENT. SIZE 8½ IN. WIDE BY 14 IN. HIGH.

to be checked upon by the cashier and countersigned by the superintendent. This account is replenished every day by a check sent direct to the bank from the main office for the amount of the expenditures shown on the daily statement, form No. 1, so that the account has always sufficient funds to its credit to meet pay roll and local expenditure.

Any money received by the field office from the sale of surplus material is remitted direct to the main office intact.

The timekeeper keeps the men's time in an ordinary time book. As a check each foreman keeps a time book of his men, and the timekeeper checks with them every night. Each night the day's pay roll, form No. 2, is made up by the timekeeper, one sheet being used for each foreman's crew. These are approved by the superintendent, the original being sent to the main office and the carbon copies placed on a spindle or post file by the cashier, after entering them up in his



FORM NO 2

DAILY REPORT

JOHN P. COWING, CONTRACTING ENGINEER.
CLEVELAND, O.

Contract No. __________ *Working at* __________ *Date* __________ *190*

Time Starting Work __________ *A. M.* *Time Stopping Work* __________ *P. M.* *Weather* __________ *Wind* __________

	NAME.	Total Time.	RATE.	AMOUNT	KIND OF WORK DONE.

Remarks __________

Correct __________ *Timekeeper*

Approved: Supt. __________

NOTE—This Report must be made out daily and delivered to Superintendent at night.

DAILY PAY REPORT. SIZE 7 IN. HIGH BY 8½ IN. WIDE.

FORM NO. 3

Mr. ____________________

____

____________________ 190__

RECEIVED OF

John P. Cowing,

Contracting Engineer,

423-427 Citizens' Building,

CLEVELAND, OHIO.

Dollars __________ *and* __________ *Cents*

Check No __________

Account of wages in full for week ending

____

____

__________ *Hours* @ __________ *Cents*

____

Signed

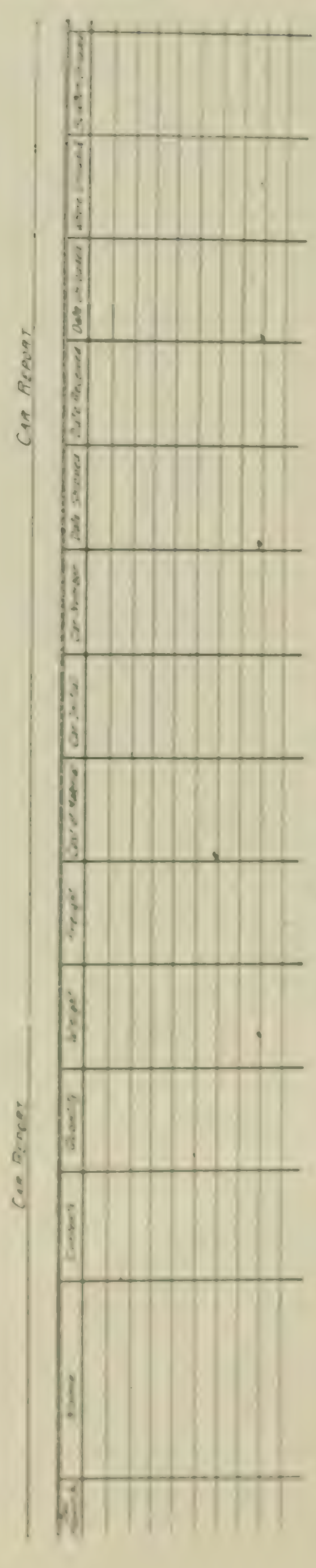
____

VOUCHER. SIZE 3½ x 7½ INCHES.

office time book. This daily time report compels the timekeeper to check up with the foreman who had charge of each man, in order to enter up the kind of work each man was doing, and consequently reduces the chance for errors in the number of hours of work actually performed.

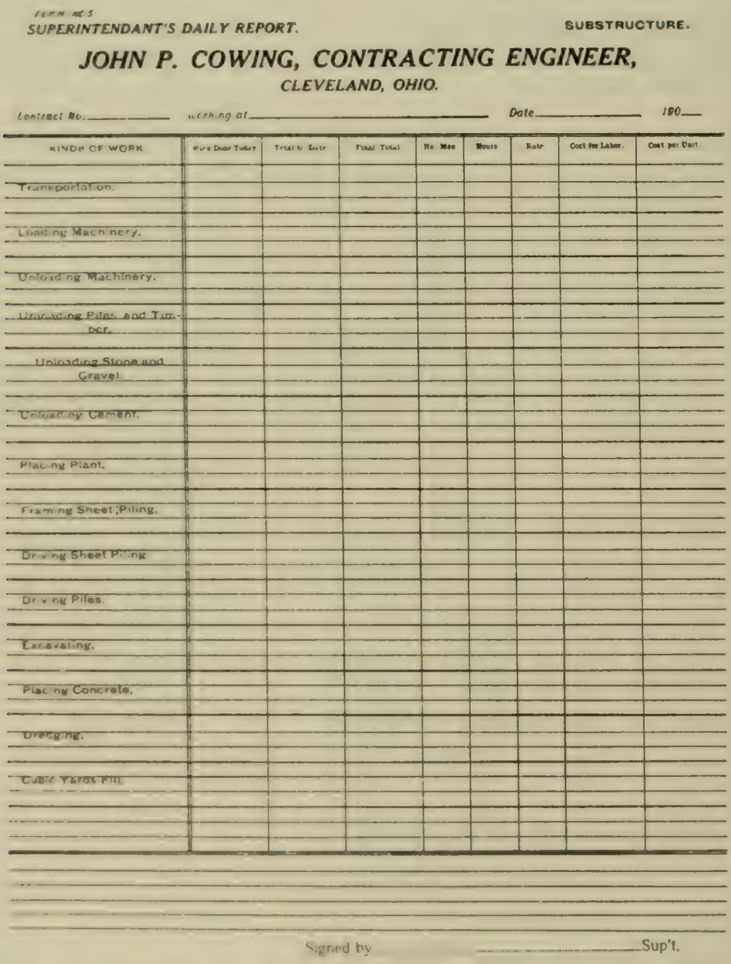
All blanks are put up in pads, the sheets alternating white and yellow in color. All reports are made in duplicate by use of carbon paper and indelible pencils, the yellow sheet being retained in the field office.

As each car of material is received, the foreman unloading it makes out a car report, form No. 7, which is entered by the cashier in the Car Record Book, form No. 4.


Car Report
Car Register

CAR RECORD BOOK RULING. WIDTH 18 INCHES.

which record book also shows the car record of shipment taken from original bill of lading, both of which together give a complete history of each car. This record book is most valuable in checking bills for material and claims for car service, and it is kept in duplicate, one in the field office and one in the main office. As nearly all material is ordered from the main office, the bills of lading are entered up in the home office car record book before sending them to the field office, and on receipt of the car report showing the unloading, the rest of the record is entered up.



Form No. 5

SUPERINTENDANT'S DAILY REPORT. SUBSTRUCTURE.

JOHN P. COWING, CONTRACTING ENGINEER,

CLEVELAND, OHIO.

Contract No.______ Working at______ Date______ 190__

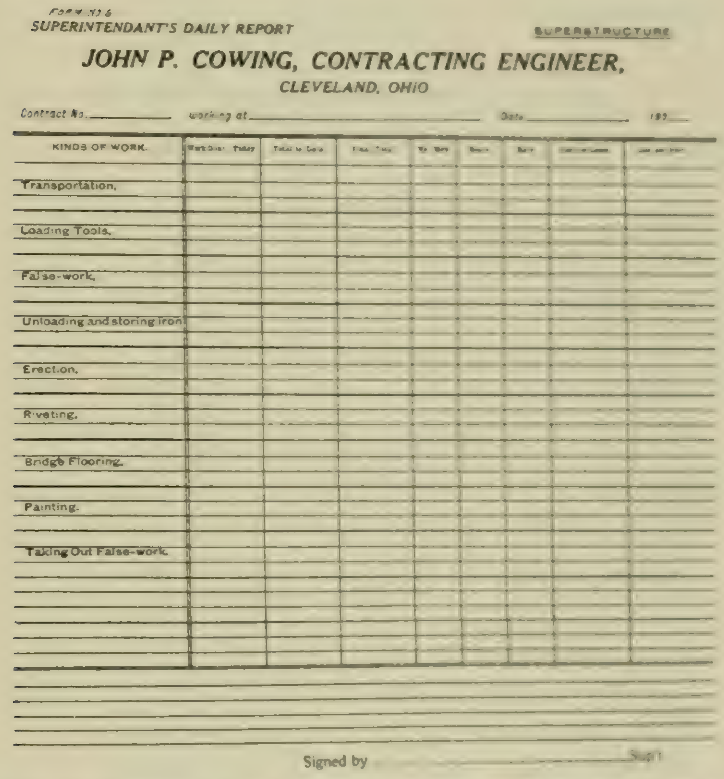
KINDS OF WORK	Work Done Today	Total to Date	Final Total	No. Men	Hours	Rate	Cost for Labor.	Cost per Unit
Transportation.								
Loading Machinery.								
Unloading Machinery.								
Unloading Piles and Timber.								
Unloading Stone and Gravel								
Unloading Cement.								
Placing Plant.								
Framing Sheet Piling.								
Driving Sheet Piling								
Driving Piles.								
Excavating.								
Placing Concrete.								
Dredging.								
Cubic Yards Fill								

Signed by ______ Sup't.

DAILY REPORT OF PROGRESS ON SUBSTRUCTURE. SIZE 8 IN. WIDE BY 11 IN. HIGH.

Any special tags or certificates as to quantity of material found on a car are attached to that car report when it is unloaded, and any discrepency is promptly reported to the shipper or railroad company, or both. On receipt of material purchased by measurement such as stone, sand, gravel, piles or timber, each car is carefully measured.

For all material purchased to be delivered by teams, as for in-



FORM NO 6
SUPERINTENDANT'S DAILY REPORT
SUPERSTRUCTURE

JOHN P. COWING, CONTRACTING ENGINEER,
CLEVELAND, OHIO

Contract No.______ working at______ Date______ 189__

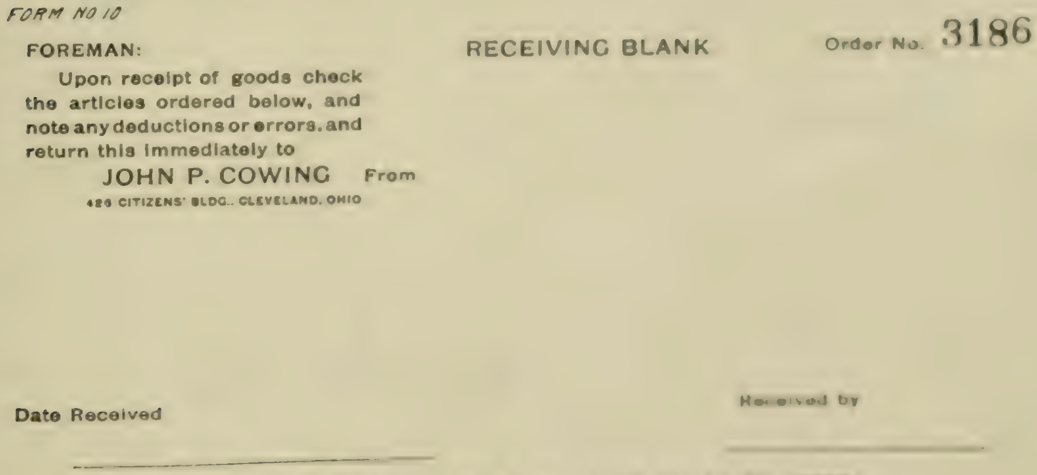
KINDS OF WORK.	Work Done Today	Total to Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Transportation.								
Loading Tools.								
False-work.								
Unloading and storing Iron.								
Erection.								
Riveting.								
Bridge Flooring.								
Painting.								
Taking Out False-work.								

Signed by ______ Supt.

DAILY REPORT OF PROGRESS ON SUPERSTRUCTURE. SIZE 8 IN. WIDE BY 11 IN. HIGH.

stance earth for filling, a receipt, form No. 8, is given to the driver, a carbon copy being kept; the purchase being made on condition that payment will be made only for the amount called for by the receipts.

Pay rolls are preferably paid by checks, and payment made Saturday nights for week ending Friday night, holding back one day's pay to give time to make up the account. Voucher, form No. 3, is used and must be signed by each man.



FORM NO 10

FOREMAN:
Upon receipt of goods check the articles ordered below, and note any deductions or errors, and return this immediately to
JOHN P. COWING
429 CITIZENS' BLDG., CLEVELAND, OHIO

From

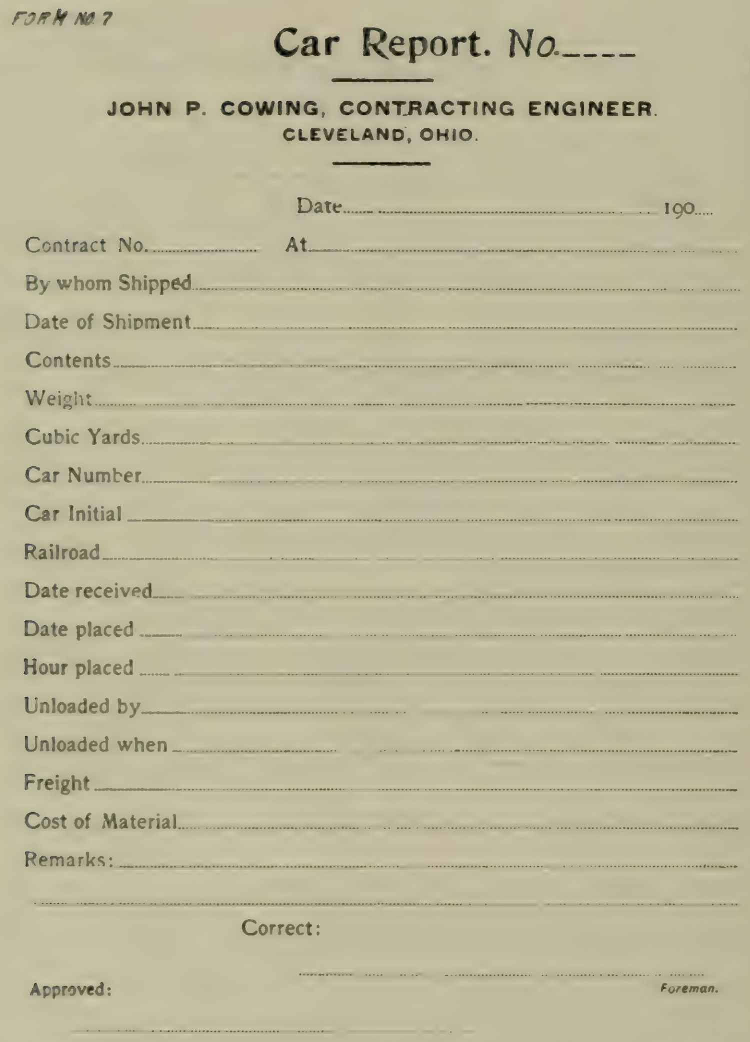
RECEIVING BLANK

Order No. 3186

Date Received ______

Received by ______

RECEIVING BLANK. SIZE 7 IN. HIGH BY 11 IN. WIDE.



FORM NO 7

Car Report. No.____

JOHN P. COWING, CONTRACTING ENGINEER.
CLEVELAND, OHIO.

Date............ 190....

Contract No............ At............

By whom Shipped............

Date of Shipment............

Contents............

Weight............

Cubic Yards............

Car Number............

Car Initial............

Railroad............

Date received............

Date placed............

Hour placed............

Unloaded by............

Unloaded when............

Freight............

Cost of Material............

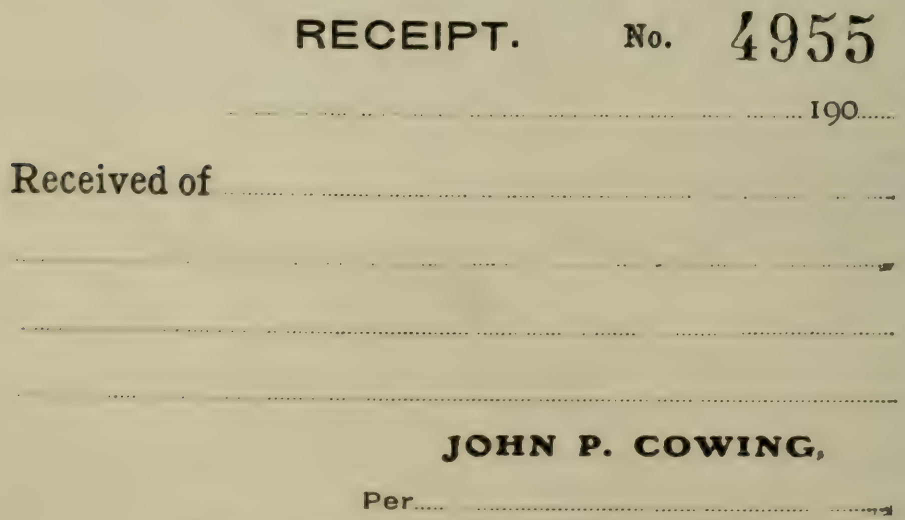
Remarks:............

Correct:

Approved:

.... Foreman.

FORM FOR REPORT OF CARS AS RECEIVED. SIZE 5½ IN. WIDE BY 8 IN. HIGH.



RECEIPT. No. 4955

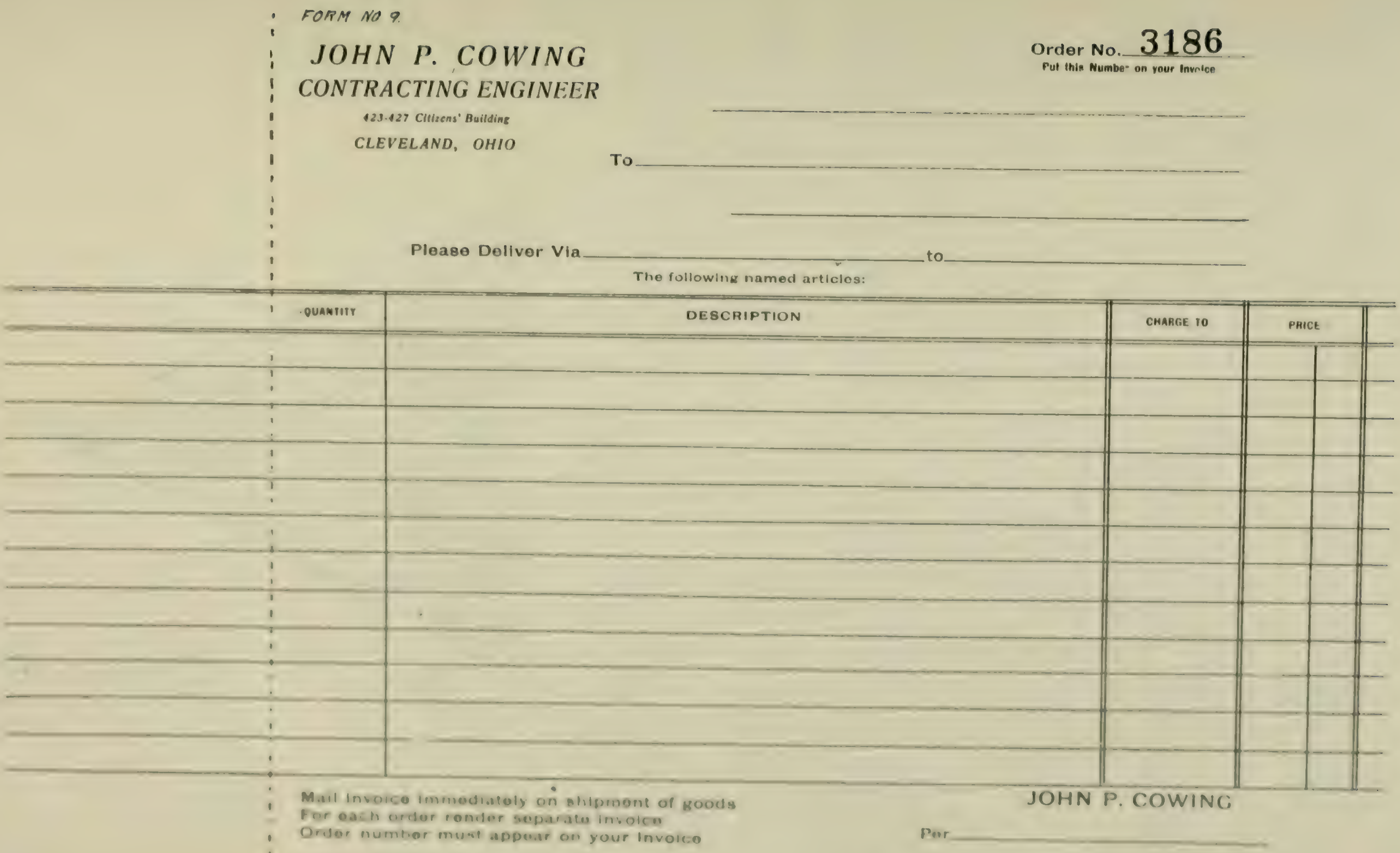
.... 190....

Received of ....

JOHN P. COWING,

Per............

RECEIPT FORM. SAME SIZE AS ORIGINAL.



FORM NO 9.

JOHN P. COWING
CONTRACTING ENGINEER
423-427 Citizens' Building
CLEVELAND, OHIO

Order No. 3186
Put this Number on your Invoice

To

Please Deliver Via to

The following named articles:

QUANTITY	DESCRIPTION	CHARGE TO	PRICE

Mail invoice immediately on shipment of goods
For each order render separate invoice
Order number must appear on your invoice

JOHN P. COWING
Per

ORDER BLANK. SIZE 7 IN. HIGH BY 11 IN. WIDE.

Order blanks, form No. 9, are made out in duplicate, one white and one pink, and a third blank of yellow, form No. 10, which is bound next to the pink sheet, and which is known as the Receiving Blank, are used in the purchase of all materials whether by the home or field office. If materials or tools are ordered by the home office to be shipped direct to the field, the yellow receiving blank, form No. 10, is forwarded to the field office and on receipt of the goods, the superintendent returns the blank receipted if the goods are O. K., or with any shortage or damaged goods noted thereon.

For all goods ordered by the superintendent in the field, even if it is only for lantern wicks, he uses the order blanks. The pink copies are kept in a loose leaf binder with alphabetical index known as the unfilled order book, until the yellow receiving blank shows the goods are received, when the pink copy is transferred to a binder known as the filled order book. This method of ordering keeps absolute track of all goods purchased and received, and does away with unauthorized buying.

This system is simple and accurate, and the forms used are the result of numerous trials. They are designed to avoid the cumbersome detail so common in many record forms. It also gives an original detail record of the work, which in case of dispute over payment for extras or otherwise, gives the contractor the advantage of having an original and undisputable record, good in any court.

EDITORIAL COMMENT

THE report of the disastrous boiler explosion which occurred on the gunboat Bennington at San Diego on July 21, last, demands comment for various reasons.

In the first place, it is a matter for congratulation that such an event can be investigated and a report rendered within one month after its occurrence, while the facts are fresh in the minds of the public as well as of those most directly concerned. If disasters can be probed so promptly, it is to be hoped that a corresponding degree of promptness may be found in the investigation of those boilers which have been for many years in use in the navy, and which have not yet exploded; it might mean a saving of life and property as well as of time.

The report of the court of inquiry states that upon arrival at San Diego the ship "was in an excellent state of discipline and in a good and efficient condition, *with the exception of the boilers*" (the italics are ours). The boilers, however, are stated to have been in "fair condition and efficient, considering their age (about fourteen years), and the use to which they had been subjected."

That is, being interpreted, the boilers were old, and had been subjected to usage, the nature of which may be inferred from the treatment given to them on July 21, 1905, on which day one of them declined to be further subjected to such conditions.

According to the report of the court of inquiry, both boilers were filled and fires started, and vigorously pushed under both until the pressure gauge on one boiler showed 135 pounds, while the fact that the gauge on the other boiler stood at zero attracted no attention. Although orders had been issued to reduce the blowing off pressure of the safety valves from 145 pounds to 135 pounds, there is no record that this order had been carried out, nor any evidence that there was any blowing off of steam from either boiler immeately before the explosion occurred. It was also evident to the court that "the hand gear for lifting the safety valves was not in working order, and there is no record, nor direct evidence, that the safety valves had been tested in accordance with the navy regulations."

As a matter of fact, it appeared that communication with the pressure gauge on the boiler had been shut off by the mistaken closing of a valve, and that the pressure, not being recorded, was permitted to increase until the furnace flue collapsed. The men directly concerned in this mistreatment of an old and neglected boiler lost their lives in the disaster, and the court of inquiry recommends that the officer in charge be tried by court martial for neglect of duty.

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THERE has been shown in some quarters a disposition to use this incident as a reason for a wholesale condemnation of the workings of the personnel law, the act by which the old distinctions between line and staff officers in the United States navy were done away, and all were supposed to be rendered capable for engineer duty. On the contrary, the Bennington affair is a striking illustration of the consequences of the non-enforcement of the law, in so far as it was the intention to make all officers engineers in fact and not solely in name. Had the personnel law been carried out as was the intention of the able and earnest officers by whom it was framed; had the expressed views of Mr. Roosevelt been carried out when, as Assistant Secretary of the Navy, he said: "What we need is one homogeneous body, all of whose members are trained for the efficient performance of the duties of the modern line officer," we should not have had a young ensign, scarcely out of the naval academy, placed in charge of the engineering equipment of such a vessel as the Bennington, with but a few machinist artificers under him.

In 1899, when the personnel bill became law, Admiral Sampson, who himself had been an active member of the Personnel Board, issued an order to the North Atlantic Squadron showing how he thought the law should be carried out, this method being the assignment of duties as follows: To all officers below the grade of junior lieutenant the duties of engineer officers for one month, and to all assistant engineers the duties of line officers for the same space of time, these duties to be alternated thereafter every month, in order that all officers should become thoroughly familiar with the demands of all departments of the service.

With such an active training in the real duties of the naval engineer, and with such a sufficient force as a gunboat like the Bennington should have had, there need have been no necessity for such a report as the present Board of Inquiry has had to make, no damaged vessel, no deplorable loss of life. Officers fully trained by practical experience in the necessity of seeing for themselves that their orders had been obeyed, and not merely content with issuing directions to incompetent and neglectful subordinates, would never have permitted the equipment to have reached the condition which naturally resulted in the disaster on the Bennington. It is not the personnel law which is responsible for the present state of affairs, but the persistent and deliberate neglect to enforce that wise and important statute in the spirit in which it was conceived and in which it was intended to be executed.

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We have reviewed at length elsewhere the report of the Royal Commission upon London traffic conditions, but we cannot emphasize too strongly the importance of the possibilities for improvement by diminishing the necessity for crowding the streets, rather than by providing increased facilities for enabling more people to move about. Formerly the only way of communicating with another man was to go to him, or to send some one else. With the introduction of the railway, the post-office, and the telegraph, much of this necessity has been removed. By the provision of a full, prompt, and wholly adequate telephone service a very large portion of the crowding of city streets might be avoided, and this, too, with a promptness which no system of new and enlarged highways could approach.

Many people seem to have the idea that business energy and effort consists in "taking cabs and going about," or in chasing with feverish activity about the streets, endeavoring to meet and talk with people who themselves are as busily engaged in trying to get to others. It is this feverish perpetual motion, resembling nothing so much as the movements of a host of animalculæ in a drop of water under the microscope, which causes much of the congestion in the streets of a great city, and the greater the facilities provided for such wasted energy, the greater will the congestion become.

THERE is another kind of congestion, that due to the daily flow of people from the residence to the business districts and back again, and this can be provided for, to a certain extent, both by greater facilities and by judicious regulation. A large part of the crowding of transport vehicles is due to the fact that the local and the long distance services are not separated to a sufficient degree. Usually the business district of a city is closely condensed and centralized, and while densely populated during business hours, its traffic is also concentrated to a few hours in the morning and evening, at which time the greatest congestion occurs at certain limited areas. By providing suitable express trains, preferably running underground, but possibly overhead, and by separating this service entirely from the local transport provisions, it would be possible to run a number of through trains from the business district to the extreme outlying suburbs without any of the delays invariably included in local transport, the result being a rapid clearing of the congestion at night and a corresponding development of suburban residence districts of but moderate population density. In such a system there should be no conflict of human currents, no mixing or confusion between local and express passengers, and above all no contraction of the flow of people in boarding the trains, since most of the congestion at stations is due to the delays in getting the passengers from the platform to the cars while others are crowding on behind them. The modern engineer should be capable of designing something far superior to the present obsolete car with its ancient platform, an inheritance from the days of hand-brakes, and give us one which shall enable a crowded platform to be cleared in the time required to pass freely over the few feet of distance involved. When a great exhibition, or even a racing event or athletic game, occurs, the railway authorities understand very well how to handle the crowds which they know will be clamoring for simultaneous transportation, and every one is familiar with the efficient manner in which long trains are rapidly supplied and as rapidly dispatched from the grounds to the homes of the multitude. The same methods, even intensified in vigor, applied to municipal transport, would work wonders, and their application might be made with but moderate delay.

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THE commercial traffic of the great lake system of North America is growing at an astonishing rate. From the Monthly Summary of Commerce and Finance of the United States for June, 1905, an adequate appreciation of the marvelous increase of this commerce can be gained. The total volume of freight received at the various ports for the first half of the current year was 19,806,321 tons, of which 10,297,436 gross tons were ore and minerals, not including receipts of coal, of which the total was 3,829,630 tons. Through the Sault Ste. Marie canals the traffic for the first half of the current year exceeds that of 1894 by nearly 10,000,000 tons.

The character of this great traffic can be judged by the fact that in addition to the transportation of ore, coal, and other minerals, as above stated, the traffic included 295,000 tons of flour, 39,719,967 bushels of grain and flaxseed, and 625,549,000 feet of logs and lumber. Of unclassified freight, 1,722,414 net tons were transported. The conception of such a vast tide of commercial traffic cannot be made vivid by figures or bald numerical statements, but a comparison of these figures with those of years past will place in a strong light the importance of the lakes to the internal commerce of

North America, and to the manufacturing industries supplied with raw materials through this route.

* * *

We have referred elsewhere to the influence which the full use of methods of communication, such as the telephone, pneumatic dispatch, etc., may have upon the congestion of streets in the business sections of large cities, and there is ample evidence to show that this method of relief is not used to its full capacity in any place. Much depends, doubtless, upon the character of the service given by a telephone company, for example, and something also upon the system employed; but so far as advantages are concerned, there can be no question as to the influence of the telephone as a means of aiding in diminishing the necessity for going about in the conduct of business matters.

The recent inquiry of the Merchant's Association of New York into the question of telephone service in Now York City revealed some interesting facts in this connection, showing not only the important relation which the telephone bears to the development of business and industry, but also the extent to which the conduct of the telephone service has become an engineering matter, involving methods and appliances wholly within the province of the engineer. Thus the introduction of the system of service charges for telephone use includes the necessity for some form of mechanical counter and recorder for keeping account of the number of calls made by each subscriber and of the districts between which the service is rendered.

Methods of determining the cost of the service have been put into use, these methods resembling closely the modern systems of works management which have been so efficiently developed of late, the costs and charges being based upon the service rendered.

The result has been a great increase in the use of the telephone in New York, that city now being far in the lead of all others.

Thus, according to the latest census reports for 1904, there were in the boroughs of Manhattan and Bronx 65 telephones per 1,000 of population, while the corresponding figures for London are but 14.2, for Paris 18.5, for Berlin 34.5, and for Vienna only 12.1. These figures are interesting, but they do not tell the whole story, since it is not only the number of telephones, but the activity with which they are used, which is the measure of their efficiency.

Any one who has attempted to save time by using the telephone in London well knows the inconvenience caused by the dilatory and unsatisfactory service, and can understand the reason why the business man prefers to incur the expense and time required to take a cab and make a personal visit rather than to attempt to depend upon the telephone.

The application of engineering methods, both in construction and operation, has resulted in giving the residents of American cities greatly improved telephone service at a diminished cost, and similar methods applied to the prompt delivery of local letters, either by pneumatic dispatch or some analagous system, would give corresponding aid in reducing the congestion on the streets.

THE ENGINEER AS AN INVESTIGATOR.

THE WORK OF THE TESTING ENGINEER IN THE STUDY OF THE PROPERTIES OF MATERIALS OF CONSTRUCTION.

Charles B. Dudley—American Society for Testing Materials.

IT is very common to regard the engineer as a man who does things, both by making the designs and by superintending the work of construction, but there is another phase of engineering work which may be likened to that of the detective, the searching out of the causes of occurrences, tracking the faults and defects of materials and structures to their origin, and enabling the responsibility to be placed and the repetition of accident to be avoided. This department of engineering has developed rapidly of late, and the testing engineer, as he has been called, holds an increasingly important position in the work of all departments of applied science.

In the presidential address of Dr. Charles B. Dudley, delivered before the American Society for Testing Materials, the work of the testing engineer is discussed in a very interesting manner, by one who has had an extended experience in this valuable department of engineering.

"It is plain that the testing engineer acts in a three-fold capacity. He is either an investigator, or a counsellor, or a judge. He is finding out new truths, he is protecting the interests of his client the producer, or he is determining by his tests that contracts are being fulfilled, or specifications lived up to, in the interests of his client the consumer. There are three kinds of testing engineers, the unattached engineer, the consumer's engineer, and the producer's engineer. It did not take long after consumers began to test materials and prepare specifications before producers found it necessary to protect their interests and defend their materials by means of testing engineers in their own employ.

"What shall be the cast of mind, and what the mental equipment of the testing engineer? We will perhaps all agree that he should be independent, self-reliant, gifted with the power of analysis of facts, as well as with the power of drawing conclusions from the data at hand. He should be ingenious in devising methods to demonstrate the points at issue, and a careful observer of data. He must keep himself free from bias or prejudice, and take especial pains that he does not deceive himself. He should be fond of experiment and have a genius for it. Above all he should be a thinker. No man who, when a problem is presented to him, simply searches his memory for whatever he may have learned in the schools, or picked up in his reading, which bears on his problem, has any especial call to be a testing engineer. The power of seeing analogies between your own problem, and one that some one else has had, is legitimate and useful, but the one who habitually and continuously approaches every problem through memory, or by studying up what others have done, is far less likely to succeed as a testing engineer than one who habitually attacks a problem by an analysis of its elements.

"But if experimenters are born, not made, what can the schools do in the way of training? Given fair mental endowment, it is possible for the schools to make excessful testing engineers, or to spoil the material they start with.

"But the mental equipment which the schools furnish is only a fraction of that needed by the testing engineer, especially if it be his duty to defend the interests of a great consumer. The schools should teach a young man how to learn, and should start him in a number of subjects, but his real education comes later. The man who expects to reach even moderate success as a testing engineer, must study harder the first five or ten years after graduation than he did at any time while in school. He must accumulate experience by arranging the information already acquired by reading, by study, and actual contact with industrial processes, and with the world's work, in every possible detail, and above all, a man must acquire experience by actual wrestling with problems that may be committed to his care. It is apparently not essential, in order to gain experience, that one should successfully solve his problems. Faraday was accustomed to say that he actually learned more by his failures than from his successes. The testing engineer should be an omnivorous student. Nothing is too trivial to interest him, nothing too remote from his present line of work to make a legitimate demand on his attention should opportunity offer. You can never tell what moment you will need, and badly need, some out-of-the-way fact."

Dr. Dudley gives some interesting examples of the manner in which the testing engineer following out a line of reasoning from the inspection of a piece which has failed, such, for example, as a broken car axle. Here an examination of the fracture and of other parts of the axle, combined with a knowledge of the methods of manufacture of the material, leads unerringly to the cause of the failure, and to the precautions to be taken to prevent its recurrence. Other examples are given, showing the great value of proper supervision and inspection, and this, together with a close following up of innumerable indications, which, to the ordinary observer might be almost imperceptible, but to the trained eye of the testing engineer lead to the revelation of the true condition of affairs.

"It may seem an idle question, but it is certainly an interesting one, as to which of the three kinds of testing engineers has the most attractive field of work. The unattached testing engineer certainly has the greatest freedom, but at the same time, the least stimulus. The producer's testing engineer undoubtedly has the best financial reward, but at the same time the narrower field. He has, however, the advantage of concentration, and as almost every modern industry has scores of unsolved problems connected with it, there is no reason, if he will work, why he should not achieve a great success. On the other hand, the consumer's testing engineer has unquestionably the broader field, the greater chance for initiation, and perhaps more important than all, an opportunity to study the behavior of materials in actual service. This last gives him a great advantage. Behavior in service is unquestionably the ultimate criterion by which every industrial product must be judged, and by which decision, sooner or later, it must stand or fall. Undoubtedly individual characteristics are a legitimate element in the choice, but our counsel would be to every ambitious testing engineer to get as near to the service as possible, and to this end to make some sacrifice if necessary to secure a position with a consumer.

"There is one more phase of the work of the testing engineer which will perhaps bear a few words, and that is the relation between the testing engineer and those whose material he is testing. This is unquestionably a delicate subject, one that we would all gladly feel did not need discussion or comment, and yet one that is constantly thrusting itself into prominence in some form. For the honor of human nature, it is gratifying to be able to put on record that during nearly 30 years of almost constant testing, only once have direct financial considerations been urged upon us to influence our verdict in regard to material. On the other hand, we have heard representatives of entirely reputable business organizations say openly, 'It costs us something to sell our goods, and it is entirely immaterial to us whether this money goes to our selling agents, or to the representatives of the consumer.' And this is not the worst phase of the matter. It is well known that the representatives of consumers who act in some sense in the capacity of testing engineers, in that their opinion or decision determines the giving of orders, not only accept substantial considerations from producers, but even demand them, if not openly, at least indirectly. An hour could readily be filled in narrating incidents of showing the forms in which the hydra-headed monster graft manifests itself. Neither side is free from blame. Strict open honesty is the only safe course. It may not be amiss to add that so insidious are the forms in which this evil manifests itself, that in the words of scripture they would at times deceive the very elect, and while it is not possible to discuss these matters, without raising interminable questions of casuistry and metaphysics, it is possible to so act as to have the continuous approval of a clean conscience. No universal rule can be given. Each one in a sense must be a law unto himself. Perhaps the best every day working rule for young testing engineers is, do nothing you would not be willing to talk over with your employer, even in the presence of the other party. It is sometimes a bit hard to resist and say 'no,' but of one thing be sure, every departure from strict integrity will sooner or later return to plague you, and should your actions ultimately result in your downfall, from none will you get less sympathy than from those who may have contributed to your disaster."

STEAM TURBINES IN MARINE SERVICE.

A PRACTICAL COMPARISON OF THE PERFORMANCE OF STEAMSHIPS EQUIPPED WITH STEAM TURBINES AND WITH RECIPROCATING ENGINES.

William Gray—Institution of Naval Architects.

ALTHOUGH much of the recent development of the steam turbine has been in connection with stationary service in electric generating stations, the earliest applications were for marine propulsion, and it is in this department of engineering that the turbine may find its most important use. For this reason the paper presented by Mr. William Gray before the Institution of Naval Architects upon the performance of the turbines installed in the Irish steamers of the Midland Railway Company is of interest, especially as it gives reliable data upon the comparative performance of both turbines and reciprocating engines in vessels of similar dimensions and construction in identical service. The discussion is of the more acceptablity since it was by the author, in conjunction with Professor Biles, that the vessels under consideration were designed.

"After careful consideration of the data available, the Midland Railway Company decided to fit two of the vessels of their new fleet with reciprocating engines and two with Parsons marine turbines. Three of the vessels, the *Antrim*, *Donegal*, and *Londonderry*, were intended for the Belfast passenger and cargo trade, and the *Manxman* for the Isle of Man summer passenger traffic, although she was also fitted with portable cabins for taking up the Belfast trade in winter. The principal dimensions of the three former vessels are as follows: Length on the water line, 330 ft.; moulded breadth, 42 ft.; moulded depth, 25 ft. 6 in. The *Manxman* is similar in form, and of the same length and depth, but the moulded breadth is 43 ft.

"The working pressure in the *Antrim*, *Donegal*, and *Manxman* is 200 lbs. per square inch, and in the *Londonderry* 150 lbs. per square inch. Forced draught on the closed stokehold system is fitted in all the vessels. The fans for this purpose are driven by electric motors in the *Antrim* and *Donegal*, and in the *Londonderry* and *Manxman* they are driven by steam engines. The engines of the *Antrim* and *Donegal* differ only in detail. They consist of two sets of the 4-cylinder, triple-expansion type, each driving a 3-bladed propeller. The cylinders are 23 in., 36 in., and two of 42 in., by 30 in. stroke. The auxiliary machinery in all the steamers is of the most modern type, and as the pumps are driven independently a better comparison is afforded of the performances of the propelling machinery.

"The arrangement of the turbines in the *Londonderry* and *Manxman* differs only in detail, but the turbines in the *Manxman* are larger, as they were designed for 25 per cent. more power than the *Londonderry*. The *Manxman* is also fitted with Parsons' vacuum augmenter. In each vessel there are three turbines, one high pressure and two low pressure. With the latter are incorporated the reversing turbines that work *in vacuo* when not in use. Each of the three turbines drives a separate shaft, and a three-bladed propeller. The low-pressure turbines are on the outer shafts, and the high-pressure turbine on the center shaft. All the turbines in both ships were made by Parsons' Marine Steam Turbine Company."

In considering the performance of the two systems comparison should be made between the *Antrim* and the *Londonderry*, since the *Manxman* is the higher powered vessel, but the data of all the vessels are interesting. Thus the conditions of the contract were that the vessels should maintain a speed of 20 knots for six continuous hours under two-thirds boiler power, while on the trials the *Antrim*, with reciprocating engines, made 20.6 knots, and the *Londonderry* 21.6, and the *Manxman* 22.65 knots, the last two being the turbine vessels.

The water consumption during the trials is tabulated in the paper, both for speeds from 14 to 21 knots, and above 20 knots for the faster steamers. No comparison upon indicated horse-power was practicable, owing to the impossibility of measuring the indicated power of the turbines.

The figures throw some light on the relative economy not only of the two systems of propulsion at various speeds, but on the different arrangements in the two turbine steamers themselves. They show that from 14 knots to 20 knots the turbine is more economical. The maximum difference occurs between 19 knots and 20 knots, which is the working speed of the vessels on service. In the case of the *Londonderry* the decrease in water consumption amounted to 8 per cent., and in the case of the *Manxman* to 14 per cent., as compared with the *Antrim* and *Donegal*.

The paper contains a tabulated statement of the coal consumption of the several steamers from September, 1904, to June, 1905, not including the fuel burned while in port, and ignoring the differences in speed and coal consumption due to the relative weights of the turbines and the reciprocating engines, the intention being to consider the subject directly from the viewpoint of the shipowner.

"The results point to a marked decrease in the coal consumption of the *Manxman*, as compared with the *Antrim* and *Donegal*. The *Manxman* did 20.3 knots for the same coal consumption that the *Antrim* had at 19.5 knots. A similar comparison of the *Manxman* with the *Donegal* gives nearly the same results. The performances of the *Londonderry* are nearly as efficient as those of the *Antrim*, but they are better than those of the *Donegal*. They also indicate that the *Manxman*, with higher steam pressure, a smaller number of revolutions and larger propellers, has done better than the *Londonderry*.

"A further economy in the turbine steamers is effected in the amount of oil used for lubrication. The logs show that this amounts in both steamers to five gallons per single trip. This again permits a further economy in the reduction of the engine-room staff from four greasers to two. Speaking generally, therefore, the performances of the turbine steamers, especially the *Manxman*, have been greatly superior to those of the steamers fitted with reciprocating engines.

"It is not possible to make a quantitative analysis of the cost of upkeep, but so far the turbines have cost practically nothing, and they require very little attention compared with what is necessary in the very best-running engines of the reciprocating type.

"There can be no doubt that one great benefit derived from the use of turbines is the elimination of the vibration inseparable from the use of reciprocating engines in Channel steamers. The engines in the *Antrim* and *Donegal* were most carefully balanced, and the vibration at the service speed is almost imperceptible. The almost unanimous testimony, however, of those who have travelled in the vessels is that the turbine steamers are steadier.

"The only real inferiority in the *Londonderry* and *Manxman* is the difficulty of manœuvring from rest in narrow waters. In this respect they compare unfavorably with the *Antrim* and *Donegal*. No doubt with further experience those in charge will become more expert in working with the small screws, but for turning from rest there is smaller power in the side propellers. Experiments were made at the trial trips that showed the turbine steamers going at full speed could be brought to rest in about 1½ minutes. This is a good result, but actual experience has shown the relative inadequacy of the backing power starting from rest. There is no good reason why sufficient backing power cannot be obtained from small screws if the reversing turbines are made powerful enough."

So far as the elements of space, weight and cost are concerned, these demand some consideration. The turbines demand much more floor space than the reciprocating engines, and while this is accompanied by a gain on upper decks, the space above can be utilized only by reducing the light and air space to the turbine room. According to the tonnage laws, this may act to increase the net tonnage of the vessel, and where the tonnage dues are heavy this may balance the commercial gains in oil and fuel.

There is a considerable gain in weight in favor of the turbine steamers, the difference between the *Antrim* and the *Manxman* being about 115 tons, or about 6 per cent. on the light weight of the steamer.

The difference in the initial cost of the turbines as compared with engines is not great. Comparing the *Antrim* and the *Londonderry*, it amounted to 1½ per cent. of the total cost of hull and machinery. In other words, for a speed of 19.5 knots the *Antrim* requires 38.6 tons of coal and the *Manxman* 35.0 tons, a saving of 9.3 per cent. The *Donegal* for a speed of 19.3 knots requires 38.7 tons and the *Manxman* 35.4 tons, a saving of 8.5 per cent.

THE ACADEMIC SIDE OF TECHNICAL TRAINING.

THE DEVELOPMENT OF INSTRUCTION IN ENGINEERING IN THE EDUCATIONAL INSTITUTIONS OF GREAT BRITAIN.

Dr. Alexander B. W. Kennedy—University College.

THERE will probably always be points of controversy as to the true relations between practical and academic training and instruction, especially when it is attempted to graft one department of education upon an institution originally devoted wholly to the other. The period included in the past thirty years, however, has witnessed a great change in educational ideas in these respects, and at no time has this progress been more clearly set forth than in the recent address of Dr. A. B. W. Kennedy, delivered before the Union Society at University College, London. Since Dr. Kennedy has been the active professor of the applied science of engineering at University College since 1875 he is qualified fully by experience to speak whereof he knows as regards matters of education, while his high standing as a practising engineer gives additional weight to his words.

Dr. Kennedy is an eloquent witness to the great work which was done in the early history of engineering education by one who is still regarded as a leader, the late Professor Rankine.

"Perhaps it may be said that Rankine was by nature rather a physicist dealing with engineering problems than an engineer dealing with engineering problems. But only those of us who have had occasion carefully to study his work from the point of view of trying to teach subjects similar to his, can ever know what an extraordinary physicist he was. Rankine was one of those men who were not only abreast of the scientific knowledge of his time, but in many ways greatly in advance of it; and many men with one-tenth of his originality, but perhaps with ten times his amount of self-assertion, have been able to obtain no mean repute as scientific thinkers."

As the demands of the time created an increasing interest in engineering education the question of the mechanical laboratory began to receive attention. Such laboratories had already been established on the Continent, but they were used primarily for original research and advanced experiments by teachers and scientific men, and not for the actual training and experimental practice of students. Professor Kennedy himself was instrumental in interesting some of the older engineers and business men in the matter, and the result was the beginning of the mechanical laboratory at University College.

"As to the general trend of our academic training, I think we engineers are entitled to say that it should be so arranged as best to train the best engineers. I put it in this way because I mean it to be understood that while on the one hand the *best* engineer is certainly not the man who knows his own business only and narrowly, on the other hand, I think we are entitled to demand that the engineer should not be looked upon as the mere by-product of the training, but as the chief result to which other things are to be subordinated.

"In saying this, however, I particularly do *not* mean that the academic training of engineers should be laid out exactly on superficially-utilitarian lines. The idea of giving a young man just as much mathematics, just as much physics, or just as much chemistry as the minimum that he can professionally require, is not only pernicious, but absolutely fallacious. There is no doubt that the only way of knowing a subject up to a certain point, in such a fashion that, up to that point, it can be thoroughly utilised, is to study the subject up to some point very much further advanced. It is not at all a valid objection to the teaching of any particular point in mathematics or physics that it is more complicated or more advanced than anything which the engineer will be likely to require in practice. That, in itself, is not an objection at all, because, as I have said, it is impossible really to master a scientific subject up to a certain—often very elementary—point without having at least a superficial knowledge of a much greater extent of the subject. But it is desirable—indeed, necessary from our point of view—that the advanced work in purely scientific subjects should be specially chosen so as best to deepen and make certain the knowledge of the earlier work."

In the teaching of applied science it is often necessary for the professor to give and for the student to receive certain statements upon authority, without any immediate proof being given. It is impossible for everything to be demonstrated upon the moment, and one of the important qualifications of a competent instructor is the ability to decide just how much he should give upon authority, and how much should be demonstrated. The student will find out for himself, later on in his work, the reasons for many things which he had to receive without proof.

"There is one matter in connection with the teaching both of mathematics and physics to engineering students which I think might well be emphasised more than is generally the case. Whether it is desirable that it should be emphasised in dealing with the general student, I do not venture to say. I mean, the point that the answer to any question can only be as accurate as the data of that question. For the ordinary examination question in mathematical physics it is necessary and unavoidable to presuppose certain data which in real life are absurd and impossible. In the ordinary everyday questions of engineering there is nothing more misleading than to take for granted the data of the examination paper; and a very great deal of the disrepute into which mathematical work had fallen at one time among engineers was due to the fact that, although the average student was able to use his methods rightly, he was unable to perceive whether they led him to a right result. I think it must be possible, even if it is not exactly easy, to point out to the student the extent to which the accuracy of his answers is influenced by the assumptions which he makes. It is, I am afraid, too often presumed that the method of working out the answer is the chief thing; perhaps it may be from some particular point of view. But for our purposes, foolish as it may sound, the method of working out the answer is only secondary; the answer itself is the chief thing, and we really *must* have that answer right when it finds itself translated into steel or stone. We would much sooner have a right answer got by an imperfect method than a wrong answer got by the best method in the world. And an answer may be wrong in two ways: it may be wrong because the data are in themselves wrong—that is to say, inapplicable to the particular case—or it may be wrong by being stated in a form much more accurate than the real data will allow of; as when we find the indicated horse-power of engines given to six significant figures, when we know perfectly well that the fourth must always be doubtful. It would be most useful if our scientific professors would discuss these points with their students, and show them specially the extent to which the methods and theorems of the mathematician and the physicist may be properly applied, when the only data available for the problems are such as actually are found in practice. It is hardly fair to leave the engineering professor to tell his pupils, or to leave the engineer to tell his assistants, that the methods they are using are quite inapplicable, and the results which they are getting obviously inaccurate. This is in every way inadvisable, and may lead the otherwise guileless student to discount all his teachers instead of only one. Every scientific experimenter knows that it is often the most difficult part of his work to say how alterations in data or want of knowledge of accuracy in data may affect the result; and I should like much to see this matter systematically dealt with by the teachers who have actually to do with the scientific or theoretical treatment of the questions concerned."

In connection with advances in technical education Dr. Kennedy makes a suggestion which has already been carried out to some extent in connection with the work of the engineering schools in the United States, that is, the association of active members of the engineering profession in the work by means of addresses, lectures, and instruction, thus bringing the students into closer contact with current work than is otherwise practicable.

"I should much like to see the development of some such connection between old and distinguished students of a college, who become later on older and more distinguished engineers, and the college at which they have studied, or some other college, as exists in the similar case of the medical profession. I do not mean simply, or indeed at all, that, for example, University College should ask senior engineers in the country, or in Westminster, to give occasional lectures to their students on special subjects. I do not say that such an arrangement may not be useful as an accidental or occasional thing; but I mean much more than this. The senior engineer may have a very large experience, and have carried out a great deal of work. But he is probably not in touch with the college, or with academic work of any sort, nor in touch with students at all; and, therefore, while he knows his subject, he may be a very unsatisfactory teacher. There are two difficulties in an older man going straight from business to lecture. One is that, being out of touch with students, he does not understand the difficulties which present themselves to young men, and which have so long ceased to be difficulties to himself, that he has even forgotten their existence. Then, secondly, having been for many years accustomed to look at his professional work entirely from the non-academic side, he really knows too much to be able to lecture about anything. He would be too apt to overload his lectures with masses of, no doubt, very important statements; which would not be appreciated by men in the student stage; and which by themselves would also probably involve difficulties of apprehension which would make their mere statement to the student useless, a condition of affairs exactly comparable with that which I have already deprecated on the scientific side of the work. My suggestion is, that to get the full benefit from its best pupils a college should, if possible, keep in touch with them after they have left it. A few years after they have left college, and when they have fairly got into the swim of professional work—but before they have so must lost touch with the difficulties of their college days that they no longer appreciate the student's point of view—they might be made to help in teaching by giving lectures on the special branches of engineering with which they were specially and actively familiar. They should do it before they have forgotten what they formerly learnt, or have had it driven out of their heads by the pressure of other ideas, and while college methods and points of view are still familiar. They would be men still making their way in their profession; still, let us hope, full of enthusiasm for their work; and certainly they would be daily finding out the differences between actual and academic problems."

ALLOYS OF COPPER.

A PRACTICAL AND SCIENTIFIC STUDY OF THE PROPERTIES OF BRONZES AND BRASSES AND SPECIAL COPPER ALLOYS.

Leon Guillet—Le Génie Civil.

FROM the earliest times the metal copper and its alloys have been used by mankind, and at the present time they may be considered as second in importance only to the iron-carbon alloys. For this reason the systematic study of bronzes and brasses recently made by the well-known metallurgist, M. Leon Guillet, and published serially in the pages of *Le Génie Civil,* is of direct engineering value, exhibiting, as it does, a résumé of the present state of knowledge concerning this important group of materials of construction.

M. Guillet divides the industrial copper alloys into six groups, the first consisting of the ordinary copper-tin bronzes; the second the special bronzes, containing in addition to the tin certain proportions of lead, zinc, phosphorus, manganese, etc. The third group includes the common brasses, containing copper and zinc only; followed by the fourth group of special brasses, used for naval purposes. The fifth group contains the aluminum bronzes, alloys of copper and aluminum; while the sixth group covers the minor copper-alloys, such as copper-phosphorus, copper-silicon, copper-manganese, etc.

The theory of these various alloys is discussed at length, using the researches of Le Chatelier, of Roberts-Austen and Stansfield, and of Heycock and Neville, together with those of the author himself, the subject being examined in the light of the methods of metallography and of photomicrography, but for this portion of the paper the reader is referred to the original and the accompanying micro-photographs. M. Guillet, however, devotes the greater portion of his articles to the practical and industrial side of the subject, and of this portion we make some absract and review.

The results obtained by mechanical tests of the various alloys have not always been consistent, and this may be partially attributed to the fact that the rapidity of cooling has a marked influence upon the behavious of alloys containing a large proportion of copper. Messrs. Heycock and Neville have plotted cooling curves showing the successive phases for copper-tin alloys containing about 90 per cent. of copper and 10 per cent. of tin, this corresponding to the so-called gun-metal, formerly used for artillery. These investigations have been carried further by M. Guillet, and he shows, broadly, that for alloys containing more than 92 per cent. of copper the resistance to rupture is slightly increased by tempering at a low temperature, from 400 to 600 degrees C., a corresponding variation appearing in the elongation. For alloys containing less than 92 per cent. of copper the breaking strength and the elongation increases in a marked degree for a tempering from 500 degrees C. In any case the maximum resistance is attained by tempering at 600 degrees C. The maximum elongation, however, varies with the composition of the alloy. Thus, for a bronze containing copper 91, tin 19, the greatest elongation appears when tempered at 800 degrees, while the alloy copper 79, tin 21, is most ductile when tempered at 600 degrees C.

In practical work bronzes are employed principally for two different classes of service: either to resist friction, as in bearings, or to resist other stresses, as in gear wheels, and the like. Bronzes for bearings vary in composition from copper 81 to 87, tin 19 to 13, the lower copper content giving the harder bronze. In practice a small percentage of zinc is usually present, and for railway car bearings an alloy of copper 75, tin 22, zinc 8, is sometimes employed.

The harder bronzes are principally used for bearings in which considerable shocks are to be resisted, as in the case of the connecting-rod boxes of explosion motors and the like, while the softer alloys are suitable for bearings having continuous and uniform circular friction.

For gear wheels and similar work the phosphor-bronze alloys are generally employed, this and some other alloys coming under the second group of special bronzes. The phosphorus acts, not by its presence as a constituent of the alloy, but by its deoxidizing effect reducing the oxides of copper and tin, and removing especially the very injurious cuprous oxide. The phosphorus is not added directly to the molten bronze, but previously prepared as phosphor-copper or phosphor-tin, containing from 8 to 10 per cent. of phosphorus, and this is added to the melted bronze in such quantity as to produce the required percentage. In the finished bronze the phosphorus often appears only in traces, having produced its effect by reducing the injurious oxides. Bronze for wire contains about 95 per cent. of copper and 5 per cent. of tin, with 0.1 of phosphorus, while for gear wheels and similar service the proportions are copper 90, tin 10 per cent., only traces of phosphorus appearing.

Bronzes containing lead are much used for bearings. In such cases the lead does not alloy directly with the bronze, but remains in separate particles, as may readily be seen by the microscope. The function of the lead is to increase the plasticity of the alloy, and this effect is produced to a marked degree. The principal difficulty in the use of lead for this purpose is found in the tendency to the separation of the lead by liquidation, the lead having a much lower solidifying point than the bronze, so that even if the metal is not poured until it has acquired a pasty consistency there is a tendency for the heavy particles to sink in the mass. It is very difficult to be assured of an equal distribution of the lead in such alloys, and the exact composition of the metal at the rubbing surface is necessarily uncertain.

Bronzes containing a small percentage of manganese are used for special purposes, the effect of the manganese being to increase the resistance and the ductility. It has been assumed that the manganese acts as a deoxidizing agent, somewhat in the same manner as phosphorus, but M. Guillet believe that this is not the case. The proportion of manganese should not exceed 2 per cent. or the the resistance of the alloy will be impaired, and the commercial bronzes of this type contain about 1 per cent. of manganese.

Bronzes containing silicon have been made to advantage, the silicon appearing to act as a deoxidizer in practically the same manner as phosphorus. A silicon-copper, containing from 10 to 20 per cent. of silicon is made, and this is added to the bronze in such proportions as are found sufficient to remove the oxides, leaving barely a trace of silicon in the alloy.

The brasses, or alloys of copper and zinc, form an important class of materials of engineering. In studying these, M. Guillet follows the same plan of examining the cooling curves and the micro-photographs of the more important alloys, and then takes up the industrial applications.

Ordinary brasses contain about 60 parts of copper to 40 of zinc, the proportions varying according to the uses to which the metal is to be put. If the proportion of copper is greater than 60 per cent. the brass can be rolled or drawn cold, but for a copper content from 55 to 60 per cent. the alloy can only be worked hot.

The principal precautions to be taken in the preparation of a brass are those to minimize the loss of zinc by volatilization. The copper is melted first, and the zinc, which has been previously heated, is quickly added, oxidation being reduced as much as possible by covering the surface of the molten metal with powdered charcoal, or even with a flux of borax. The metal should be poured into the ingot moulds with great care: if the temperature is too high the alloy will be porous, while if it is too cool the product will not be homogeneous.

In the process of hot rolling a bar may be subjected to a considerable reduction at the first pass, and then, after reheating it can be brought to the finished size. This method, however, produces a metal of coarse grain, with greater hardening than is produced by careful cold rolling. The annealing of brass should be effected at a temperature of 550 to 600 degrees C. If the temperature falls below 550 degrees the annealing will be but partially effected, a portion of the hardening due to the rolling remaining, while at a higher temperature than 600 degrees the metal is apt to become burnt.

M. Guillet gives the composition and properties of a number of brasses, some of the most important may be noted. Thus brass for cartridge shells contains from 67 to 72 per cent. of copper, while for making brass screws the alloy is 60 copper, 40 zinc. Common yellow brass for castings generally contains 2/3 copper to 1/3 of zinc, but metal for this purpose often includes scrap of unknown composition, introducing lead, tin, and iron into the product. The best metal for drawing into wire contains about 70 copper, 30 zinc, and especial care should be taken to insure the absence of lead.

So-called brazing metal, or brass solder, for making joints in brass, iron, or steel, is of interest, and in this case the fusibility of the alloy is of importance. A common soldering brass is made of copper 34, zinc 66, but this is not very strong. Better solders are of more complex composition, such as: copper 44, zinc 50, tin 4, lead 2. For brazing iron or steel a good alloy is: copper 70, zinc 30, or copper 67, zinc 33, but these require a much higher temperature for their fusion.

The special brasses include those containing lead, tin, manganese, aluminum, etc.

Nearly all brasses contain a small proportion of lead, introduced with the scrap metal, but the amount should not be permitted to exceed 1 to 2 per cent. Ordinary brasses will be found to contain 0.4 to 0.6 per cent., while as much as 0.5 per cent. may be intentionally added to increase the facility of moulding unless especial strength is wanted in the product.

The addition of tin produces a marked modification in the properties of the alloy, raising the ultimate strength and the elastic limit, and reducing the elongation and the contraction of area. It also increases the hardness, and especially improves the resistance to the corrosive action of sea water. A special brass for naval use contains: copper 60 to 62, zinc 39 to 37, tin 1.5.

Manganese brass, originally made by Parsons in 1876, is a valuable alloy, containing from 2 to 4 per cent. of manganese. The effect of the manganese is to increase the ultimate resistance and the elastic limit, without producing increased brittleness. Brass containing manganese is extensively used for screw propellers, rudders, and other important marine castings.

Aluminum brass is another alloy, the presence of the aluminum permitting a brass of 70 copper, 30 zinc, to be readily forged while hot.

M. Guillet devotes one paper to the consideration of the special alloys of copper with metals other than tin or zinc, the most important of these being the aluminum bronzes and the manganese bronzes. The aluminum bronzes are of two extreme classes; the aluminum bronze strictly so-called, containing about 90 copper and 10 aluminum, of high resistance and ductility; and the alloy containing a small percentage of copper, and generally sold under the name of aluminum, this being used for certain parts of automobiles on account of its lightness.

Manganese bronze, consisting of copper 95.5, manganese 4.5, is especially valuable because of its resistance to the corrosive action of vapors and liquids, being employed for various purposes in chemical works, and the like.

Space prevents a more detailed consideration of the alloys discussed by M. Guillet, but his articles form a valuable contribution of mechanical technology, and contain much useful special information.

LEAKAGE OF STEAM ENGINE VALVES

THE INFLUENCE OF VALVE-LEAKAGE UPON THE PERFORMANCE AND DESIGN OF STEAM ENGINES.

Professor R. H. Smith—The Engineer.

RECENT reports of tests and investigations upon steam-engine performance have called attention to the fact that the valves by which the admission and exhaust of the steam from the cylinder are controlled are by no means always as tight as has been supposed. It has even been maintained by some investigators that a considerable proportion of the loss hitherto supposed to be caused by internal condensation may be due to the leakage of the steam past valves supposed to be tight, but in reality quite leaky. In a discussion of the recent report of the Steam Engine Research Committee of the Institution of Mechanical Engineers, published in the *Engineer*, Professor R. H. Smith examines some of the conditions surrounding the operation of steam-engine valves, and his discussion will be found both interesting and profitable.

Taking up the question of the form of the valve with respect to its possible tightness, Professor Smith shows that a study of leakage should be made in a thoroughly scientific manner.

"In order to establish the laws of leakage through a sliding joint, flat slides are, no doubt, the simplest, and, therefore, the best forms to experiment with; but with drop valves one has to do with a fixed and not a sliding joint. If one wants to investigate leakage through a sliding joint, surely the scientific method is to use a slide covering only one port, namely, the exhaust port; to arrange means whereby the mean lap may be varied without altering the fit between the sliding faces; to arrange means of varying the mechanical pressure between the faces independently of the pressure which produces leakage; to adopt means of varying the fit between faces independent of all other change, and of varying the temperatures as well as the pressures effective in producing warpage of either face. So far as influence of fit is concerned, in order to obtain exact quantitative results, of course cylindric or piston slides offer superior facilities for experimentation, but the results cannot have much significance as regards flat slide leakage.

"Workshop experience with manifold forms of valve has long since demonstrated that the true secret of steam tightness lies in the design of valve and seat together in regard to mass, shape, and surface exposures to live and exhaust steam respectively such as, while it leaves both valve and seat the greatest practicable freedom to change in size under variations of temperature and pressure, will also keep both of unchanged shape. The old pattern of flat slide valve, designed without this modern knowledge of the real conditions of success, cannot yield results of important significance in steam engine research."

There seems to be little doubt that drop valves, or poppet valves, as they have been called, are preferable either to flat slides or to Corliss valves, for engines of modern design. Drop valves have been employed, among other reasons, to obtain quick cut-off, and some of the most efficient engines of Continental builders have been designed with such valves, but they have other advantages. They can be made tight, and when the valve and its seat are properly designed, they will remain tight, even when used with highly superheated steam, a condition which must be accepted as necessary if the highest economy is to be obtained. In fact it is well recognized that the drop valve is the only reliable type for use with internal-combustion engines, in which the temperatures far exceed those of the highest superheated steam.

"As regards leakage, a distinction should be sharply drawn between leakage between a pair of very narrow bearing surfaces, such as those of drop valves, and that between wide lap surfaces, such as those in flat, piston, and Corliss slides. In the former case the leakage approximates to the flow through a pin-prick in a thin plate, and there is no reason to suppose that the passage between the metal surfaces compels condensation of steam in any degree greater than in the small orifice in the thin plate. If the bearing edge has more than a certain width, there may be a simmering leak, which means that the leaking material issues as liquid, and boils immediately it escapes into atmospheric pressure. But if it were a sharp knife-edge there would be a blow through of steam alone if only steam arrived at the high-pressure side of the joint.

"It would be interesting to discover the limit of breadth that separates this kind of leak from that through wide lapping surfaces. Here the high conductivity of the metal promotes a more or less rapid flow of heat towards its cooler parts; this flow keeps the metal surface which is in contact with the steam at a lower temperature than the layer of steam within its radius of direct thermal influence; and consequently heat flows from the steam to the metal, or rather, to both the opposite metal faces. There is an extremely thin layer of steam to give up heat; its latent vapour heat is soon exhausted, and it is liquefied before it has penetrated far beyond the in-edge of the lap joint. Beyond this—that is, through nearly the whole length of the leakage passage—the leak is a flow of liquid. It cannot be too constantly borne in mind that a flow through a narrow channel in which the drop of pressure is spent in overcoming viscous and frictional resistances is a purely volumetric phenomenon; by which is meant that for given drop of pressure per inch length, given cross-sectional dimensions of the channel, and given viscosity and friction coefficients, the volume of flow per second will be the same, whatever be the density of the fluid passing. As water is a thousand times more dense than steam, a thousand times as great a weight of water would leak per second as of steam if there were no difference between the friction and viscosity coefficients and no difference between the pressure gradients across the leak with water and steam. In a water leak the pressure gradient is almost certainly uniform except for variation in the closeness of the two metal surfaces, while in a perfectly dry steam leak, because of the expansive character of the fluid, the pressure gradient will not be uniform, and the whole of it will not be spent on friction and viscosity, part of it being spent on mass acceleration. Thus the two cases differ largely, beyond the limits of mere difference of friction and viscosity coefficients; but the excess of water density is so enormous that wherever the leak passage is long enough to produce sufficient delay to induce liquefaction of the steam, the rate of leakage measured by weight must be much greater than in dry steam leakage. This excess will evidently become more pronounced if at entrance into the leak the steam be already wet."

There is one lesson which may be drawn from the study of valve leakage which has not been brought out as fully as it might be, and that is the great advantage of a steam engine which has no valves, and in which the steam passes through in a continuous flow, as in the case of the steam turbine. Apart from the gain in construction, this question of the elimination of valves, which, even if tight when new may become leaky after a short period of service, is well worth considering, and it is not the least of the numerous advantages of the turbine type of steam engine.

CARBON-FILAMENT INCANDESCENT LAMPS.

IMPROVEMENTS IN THE PREPARATION OF CARBON FILAMENTS FOR INCANDESCENT ELECTRIC LAMPS.

John W. Howell—American Institute of Electrical Engineers.

We have reviewed recently in these pages the developments which have been made in the use of metallic filaments for incandescent electric lamps, and the work of Feuerlein and Von Bolton with the tantalum lamp, and of Auer von Welsbach with the osmium filament, indicates that the carbon filament must be improved as well if it is to hold its own. At the recent meeting of the American Institute of Electrical Engineers Mr. John W. Howell described some improvements in carbon filaments which may go far to enable the earlier form of lamp to maintain its position in the domain of incandescent electric lighting, and some account of the results will be found of interest.

"In briefest outline, the new characteristics of the filament may be said to be due to the proper application of excessively high temperatures to the ordinary carbon filament. The value of the product is determined by the conditions under which the high temperatures are applied.

"It is well known that an ordinary incandescent filament in an evacuated lamp may be heated to excessive temperatures by the application of high current without producing any beneficial change in the filament. To produce the effects described in this paper the heat is externally applied to treated filaments at atmospheric pressures. The simple application of the highest attainable temperatures to the plain carbonized cellulose fiber, i. e., the so-called 'filament base,' is also incapable of producing any considerable change in the filament. This high temperature treatment of the base is, however, a beneficial step in the process here described.

"Before describing the new process, it may be well to recall the steps by which the standard filaments are made. A solution of cellulose is squirted through a die into a liquid that hardens the cellulose. The resulting fiber is dried, then shaped into the desired form for the finished filament and heated in a muffle until carbonized. In this process the highest temperature of a gas-furnace is employed. The into the desired form for the finished filament.' The base filaments are usually separately heated by a current passed through them while they are surrounded by an atmosphere of hydrocarbon vapor, and in this way a coat or shell of graphite is deposited upon them. They are then said to be treated filaments. The best quality of standard carbon incandescent lamps of today owe their superiority to the use of treated filaments.

"In attempting to graphitize carbon filaments it was discovered that treated filaments undergo very remarkable changes when subjected to the highest possible temperature of an electric resistance furnace. The furnace consisted of a carbon tube, held at the ends by large water-cooled copper clamps; the tube was imbedded in powdered carbon to prevent its combustion. The filaments were packed in small, cylindrical carbon boxes, which were fed into the heated tube. The temperature was usually between 3,000 and 3,700° C. Under such firing the ordinary treated filament changes in appearance; its graphite coating looks as though it had been melted, and its specific resistance is greatly reduced. The resistance of one of these filaments, measured at ordinary temperature, may be reduced as much as 80 per cent. by the firing."

The results of tests made by using such filaments in incandescent lamps are given by Mr. Howell in the form of resistance-temperature curves, enabling comparisons to be made between the treated and the ordinary filaments.

There is every reason to believe that filaments prepared according to the process described by Mr. Howell will have a longer life and give a higher degree of efficiency than the untreated filaments. At the present time the most effective carbon filament in general use operates at 3.1 watts per candle, and under accurate test conditions it gives a useful life of about 500 hours, to 80 per cent. of its initial candle power. With the new filament a useful life of about the same length is obtained, while the consumption of energy is only about 2.5 watts per candle, which approaches the performance of the tantalum and the osmium lamps.

"The appearance of a filament fired both before and after treating is very different from that of one fired after treating only. The former has a slightly pebbled appearance, as seen through a microscope, and a rather dull-gray color. The single-fired treated filament is generally very much blistered, many blisters extending outward a distance greater than the diameter of the filament. These blisters indicate an outflow of gas from the base when the shell was in a soft condition. The surface of the filaments is highly lustrous.

"The specific resistance of the highly heated coating has been found to be as low as 0.00006 ohms per cubic centimeter, which is very much lower than the specific resistance of any other known form of carbon or graphite. Its specific gravity is also much higher than it was before heating. Its changed nature is also indicated by its toughness and flexibility. The coating of a double-fired filament may be pulled off in short tubular sections, which if pressed flat, will spring back to their original form when the pressure is removed. The same coating before being fired is comparatively brittle, and will break with very little pressure. On account of the positive resistance curve and physical characteristics of these filaments, they have been given the name 'metallized filaments.'

"The treated coating on filaments, even before firing, is graphite, as determined by the chemical test established by Berthelot—the production of graphite acid (a yellow insoluble substance) when treated with a mixture of anhydrous nitric acid and potassium chlorate. Ordinary carbon is dissolved by these reagents. The coating on the treated filament has also the greasy feel of graphite, and gives the characteristic mark of graphite on white paper. After being heated to high temperatures in the electric resistance furnace these characteristics continue and the chemical re-tion becomes very much more marked.

"Metallized filaments blacken the lamp-bulb very much less than ordinary filaments. This may be due to the removal from the former of practically all the mineral ash and other impurities, or it may be due to the changed character of the carbon itself.

"Bamboo, coated by dipping in a solution of asphalt, is altered by firing, the coating changing to graphite and giving the characteristic positive curve. Silk dipped in a sugar solution also gives the same result.

"The base of a metallized filament, from which the treated coating has been removed, when mounted in a lamp has been found to give the resistance curve of a fired base. Pieces of the coating, about 1.5 in. long, mounted in lamps, have been found to give the strongly positive resistance curve that is characteristic of the metallized filament. These observations show that the change is practically all in the treated coating and not at all in the base.

"Metallized filaments, as above described, are much more stable at high temperatures than ordinary carbon filaments."

The recent development of interest in the incandescent electric lamp is most encouraging, and the number of candidates in the field, and the fact that they are being developed by competing manufacturers, adds to the possibilities, and the consumer should obtain some portion of the benefit. The Nernst lamp appears to be in a fair way to fill the demand for a lamp of intermediate power between the carbon glow lamp and the arc lamp. The tantalum lamp has shown an efficiency of about 2 watts per candle, and the osmium lamp claims a consumption of about 1.5 watts. If the new filament of carbon does not cost too much to manufacture, and can be produced with a fair degree of uniformity it will be able to meet the metal filaments very closely, and it may be improved so as to compare with them in life as well as in efficiency.

THE TRAFFIC PROBLEM IN LONDON.

PROPOSED METHODS FOR IMPROVEMENT IN LOCOMOTION AND TRANSPORT CONDITIONS IN THE STREETS OF LONDON.

Report of the Royal Commission.

IT has long been recognized that some improvement in traffic conditions in London was necessary, and more than two years ago a Royal Commission was appointed to investigate and report upon this important question. The subject is one which interests not London alone, but concerns also many other large cities suffering from the congestion which forms such a difficult problem in municipal affairs. The report of the Commission has now been made public, and some abstract of the information and suggestions will be found of interest and value, not only at home, but in many other places.

Like nearly all large cities, London consists broadly of a business and commercial quarter, and of a residence district or district with a daily flowing and ebbing tide of humanity, and this tide is obliged, for a portion of its course, at least, to pass through streets originally designed to meet the conditions of several centuries back. After the great fire of 1666 Sir Christopher Wren, with a foresight most unusual, suggested that the necessity for rebuilding the burned district be made occasion for widening streets, straightening crooked ways, and providing broadly for immediate and future growth, and his plans, which are yet in existence, would have been the basis of an immense improvement, could they have been carried out at that time. Difficulties in connection with property lines, together with the general lack of united effort at the time, caused Wren's invaluable suggestions to be ignored, and the city was rebuilt on practically the original lines; and the result is that London is attempting to conduct the business of the twentieth century upon thoroughfares which were insufficient for the traffic of the seventeenth century.

It is true that successive attempts have been made to improve the traffic conditions, but such improvements have usually been made under the pressure of excessive congestion, and not with a regard for future demands, and hence the relief has been but temporary. In fact it has been asserted, and with much force, that all attempts to provide improved transport facilities have only resulted in creating an increased congestion, by reason of the greater number of people brought into the metropolis. The replacement of the stage coaches by steam railways was followed by a rapid increase in the population of London. When underground transport was begun it was found that the crowding of the streets was not perceptibly diminished, and at the present time the more tubes there are the more seem to be demanded.

The omnibus has done its work well in the past, and either horse-drawn or mechanically propelled, it will doubtless long continue to be used, but its limitations are those of the streets upon which it must travel. Electric trams have been extensively employed in other cities, notably in the United States, where the transport problem in large cities is almost as pressing as in London, but tramcars are almost as dependent upon street capacity as are omnibuses, while, as Col. Crompton has well pointed out, the omnibus has an "overtaking power" which the tram-car lacks.

It is evident that means of relief cannot be the same for all cities, and that geographical conditions have an important influence upon the methods which can be considered for any given case. The Chairman of the Commission, Sir D. M. Barbour, and a number of the members, visited the United States, and examined the systems in use in New York, Philadelphia, and Boston. Of these cities Philadelphia most nearly resembles London in general conditions, while New York is the most remote, consisting, as it does, of a tongue of land extending between two wide rivers, the business district being concentrated in the lower portion and the residence section occupying the balance, with wide avenues running lengthwise for the greater portion of the distance. For such a situation it is entirely practicable to provide longitudinal arterial transport systems, both overhead and underground, but the conditions in London are so different as to render comparison impracticable.

The inquiries of the Commission showed that the total number of rides per capita for London, with its population of 6½ millions, is about 200, not including trunk-line service, while in Berlin the number is 270, and in New York 300. The only way in which provision can be made for the increasing demand is by the opening of new streets and the provision of new railways. Following out this idea, and being governed, doubtless, by the shape of Greater London, the Commission proposes, as the principal basis of relief, the opening of two main avenues, one east and west, connecting Bayswater-road with Whitechapel, a distance of 4¾ miles, and the other extending north and south a distance of 4½ miles, connecting Holloway with the Elephant and Castle. The roads are to be 140 feet in width between the house lines, and provided with four lines of surface tramways, and four lines of subway track, giving both express and local service.

The cost of such a work, taking into account property values in London, would be from £25,000,000 to £30,000,000, but with the outlay there would also be brought into existence the immense income producing elements of the surface and underground railways, properties which would seem more than capable of earning the interest on the cost of the entire improvements. The report also includes recommendations as to the widening of existing streets and other improvements, which, if all carried out, would practically result in a rebuilding of many portions of the metropolis. This undertaking is of such magnitude that its execution must extend over a long period of time, and since improvements must be necessarily made in the course of time it is far better to have them executed in accordance with a general and systematic plan than to conduct a number of independently conceived works.

Apart from any plans for the amelioration of traffic conditions, however, there is much relief to be obtained by the improvement in general facilities for communication. There is no doubt that a highly efficient telephone system would do as much to relieve traffic conditions in London as it has already done in other places, and much of the crowding of the streets of business quarters would be avoided if it were rendered unnecessary to hold personal interviews for all communications which could be made by telephone. The time gained by a prompt and efficient telephone system is thus a double gain, and there is no necessity for delay in making this improvement. The use of pneumatic dispatch tubes, both for parcels and for local letters, is another means of partial relief, and in general the immediate remedy for congestion appears to be the provision of such methods as can be devised for diminishing the necessity for running about the streets.

There is no permanent remedy in sight, and none can be expected, since the principle that "facilities create traffic" holds as good in the streets of a great city as it does upon the great highways of commerce, but existing conditions can be improved, by some of the methods indicated.

DIRIGIBLE-BALLOON CONSTRUCTION.

PRACTICAL EXPERIENCE IN THE CONSTRUCTION AND OPERATION OF THE LEBAUDY DIRIGIBLE BALLOONS.

H. Julliot—Société des Ingénieurs Civils de France.

IT is interesting evidence that efforts to construct machines for the navigation of the air have passed into the domain of practical engineering, when papers upon the once derided subject are seriously presented and discussed before engineering societies of the highest reputation. This is especially significant when such papers represent accounts of work actually accomplished, and are not confined solely to academic discussions of unproved theories.

While it is believed by many eminent engineers that final success will be attained in aerial navigation by an apparatus which is itself heavier than the air, it is none the less realized that in the present state of the art some form of dirigible balloon must be employed for actual experimental operations of any magnitude. From the experiments of Renard down to the latest trials of the recent dirigibles, public attention has been directed to the possibility of employing some form of gas bag, sustaining a car containing a light motor operating a screw propeller, and while it is generally admitted that such a machine is really only a transitional device between the drifting balloon and the wholly controlled and self-sustaining aeroplane, it is certainly the machine of the present, and as such, entitled to respectful consideration.

In a paper recently presented before the Société des Ingénieurs Civils de France by M. H. Julliot, and published in the *Mémoires* of the society, there is given a very complete account of the numerous experiments which have been made since 1899, under the auspices of MM. Paul and Pierre Lebaudy, with the dirigible balloon which bears their name. Such an account, prepared by the engineer who has been most intimately connected with the work, and by whom the various parts have been designed, forms a most valuable contribution to the science of aeronautics, and some abstract and review of the paper is here given.

There is no doubt that the development of the dirigible balloon has been largely due to the progress in other departments of industry. Thus, M. Julliot refers especially to the value of the 12 per cent. nickel-steel alloy, which, after careful annealing, has a tensile strength of 100 kilogrammes per square millimetre, or about 142,000 pounds per square inch, showing at the same time an elongation under test of 18 per cent. This material, when drawn into tubes of 20 to 40 millimetres in diameter, with thicknesses ranging from 0.6 to 2 millimetres, permits the construction of a framework of considerable strength and extreme lightness.

The development of the automobile industry has also rendered it possible to produce motors of high power and extremely light weight and this has also contributed to the development of the dirigible balloon. Thus it has been found possible to make an operative motor weighing not more than 10 kilogrammes per poncelet, or only about 7½ kilogrammes per horse power, and a consumption of only 425 grammes of essence per poncelet (315 grammes per horse power), so that the increased strength of the structure and the decreased weight of the motor united to aid the designer very materially in his difficult work.

M. Julliot emphasises the necessity of using pure hydrogen gas as the substance for filling the balloon, since it gives an ascensional force of 60 per cent. greater than is attainable with ordinary illuminating gas. In actual practice the gas is produced by the reaction of iron with ordinary sulphuric acid, the product being purified by washing to remove any acid, and by treatment with a mixture of sawdust, lime, and sulphate of iron, to absorb the hydrogen sulphide, both of these impurities being injurious to the fabric of the balloon. This is followed by the passage of the gas through cylinders containing a mixture of fossil meal and permanganate of lime, this being for the absorption of the hydrogen arseniates and phosphates, together with the carburets which would increase the specific gravity of the gas. Finally the gas is passed through caustic soda, to remove any trace of carbonic acid, and it is only after such a course of purification that it is held to be suitable for the purpose of filling the balloon. In this purified state the gas is possessed of so little odor that it has been found necessary to add a perfume in the form of muronine, in order to enable leaks to be detected by the sense of smell.

Pure hydrogen gas, containing about 2 per cent. of oxygen, has been prepared by the electrolytic decomposition of water, and this gas, compressed in cylinders to pressures of 100 to 150 atmospheres, has been found especially convenient for refilling the balloon at distant points, since the gas can be shipped by rail. The weight of the containers is such that they cannot be carried to advantage in the machine, but they have been successfully used at points of descent. Hereafter it may be found practical to carry light reservoirs of liquid hydrogen, and replenish the balloon en route, but the cost has rendered this plan impracticable for the present.

A most important element in the success of the apparatus is the balloon itself, since it must be made as tight as possible, and be held rigidly to its predetermined form, while being at the same time of minimum weight. The most available material for the balloon itself has been found to be a cotton fabric coated with india rubber, and the final construction adopted for the Lebaudy machine consists of two layers of cotton fabric, alternating with layers of vulcanized rubber, this weighing 330 grammes per superficial metre. If a larger balloon should be constructed in the future there yet remains silk as a still stronger substance. The internal layer of vulcanized rubber protects the fabric from the action of the gas, and by making the material of a yellow color the rubber is protected from the actinic effects of sunlight.

The general form of the Lebaudy balloon is that indicated by Renard many years before, being in the shape of a cigar, with the greatest diameter somewhat forward of the centre, and with the rear rounded off, while the front end forms a sharp point. Experience has shown the impracticability of stiffening such an envelope by any internal or external metallic bracing, and the shape of the balloon itself, and the pressure upon the internal ballonet must be relied upon for this purpose. The Lebaudy machine of 1904 has a balloon of a total length of 57.75 metres, or 189.5 feet, and a maximum diameter of 9.80 metres, or 32.15 feet, with a volume of 2,666 cubic metres, giving a sustaining capacity of a little more than 3,000 kilogrammes, or about three tons This is sufficient to lift all the structure and machinery, together with four persons, fuel enough for seven hours' operation, and 300 to 350 kilogrammes of ballast.

M. Julliot describes in detail the light, but rigid tubular frame work below the balloon, carrying the car, the motor and the propelling machinery. The motor of the 1904 Lebaudy is a 40 horse power Mercedes, with four, four-cycle cylinders, running at a normal speed of 1,000 revolutions. and capable of regulation from 250 to 1,200 revolutions per minute. The crank shaft of the engine is placed across the axial line of the balloon, and connected by mitre gearing to the two propeller shafts, there being twin propellers, running at the same speed as the motor. The outside diameter of the two-bladed propellers is 2.44 metres, the inner ring to which the blades are attached being 0.5 metre, and it has been found that better results are obtained with propellers of moderate size, running at a high speed than with larger wheels, moving more slowly.

This machine has made a large number of trips in all kinds of weather, and the details of some of these excursions are given in the paper of M. Julliot, showing that such an apparatus can maintain a satisfactory equilibrium, and can be well controlled, even in windy weather; the results, so far as wind is concerned, depending principally upon the power of the motor. Much valuable experience has been undoubtedly gained, and even though one may very properly maintain that such machines do not represent the ultimate type of flying machine, they undoubtedly give many opportunities for investigation in the great problem of aerial navigation.

ELECTRICITY IN COAST DEFENSE.

A SCHOOL WHERE OFFICERS OF THE ARTILLERY OF THE UNITED STATES ARMY ARE TAUGHT HOW TO USE ELECTRICITY IN WAR.

Electrical Review.

THE development of the war between Russia and Japan has emphasized the importance of the protection of harbors by properly arranged submarine mines, and as it is always important to prepare for war in time of peace, so it is interesting to examine the extent to which other nations have availed themselves of the latest progress in science for the defense of its coasts and seaports. In a recent issue of the *Electrical Review* (*New York*), there is given an account of the work at Fort Totten, where the artillery officers of the United States army are instructed in the use of the latest methods of defense by the use of mines and of electrical control of high explosives.

The coast of a country is protected from foreign attack in two different ways: first, by the navy; second, by the coast defenses erected to protect each separate harbor.

"The responsibility for the coast defenses rests with the artillery. The military engineers may plan and build a fortress, but the artillery must hold it, defend it, and beat off hostile attacks. In the modern way of doing this electricity is becoming one of the most important factors.

"There are two ways of defending a harbor which comes under the artillery's care. The one is by mining, the other by gun fire. Mines may be of several kinds. For defending a harbor they are generally anchored in known positions. In general, they consist of large pressed steel vessels having either a spherical or cylindrical form. Within them is placed a charge of a high explosive, which, in some classes of mines, would be detonated by coming in contact with a vessel, or which might be harmless until fired by means of an electric current controlled from the shore. The two types may be combined so that the mine may be fired either by contact or from the land.

"Those mines which are fired electrically necessarily call for careful work, not only in arranging the firing device, but in connecting this to the firing station on land by means of a submarine cable. These cables are led to a controlling switchboard placed in a building well out of danger from hostile fire, and here is stationed the officer, who, at a given signal, fires the designated mine. The switchboard to which the mine cables run provides not only for firing the mine, but for testing its condition at any time. The power supply must be always ready for use at a moment's call.

"There are several ways by which the signal to fire a mine may be given. The vessel itself, by striking the mine, may give the alarm which leads to its destruction, or the method known as judgment firing may be adopted. The simplest way, of course, would be to use contact mines which would explode as soon as struck, but the objection to these is that they are nearly as dangerous to friends as to foes. Those mines which can be fired from the shore may be perfectly harmless until the firing current is sent through them. They can be set off even though the hostile ship be not in contact with them, and thus disable it. In the method known as judgment firing a range-finder is placed in a fire-control station at some point which commands the waters which have been mined. The position of every mine is carefully plotted on a chart, so that if the location of a hostile vessel be known, it will at once be seen whether she is in proximity to a mine. Upon the approach of a vessel she is watched by the range-finder, who not only determines her direction from the station and her distance, but the course she is following and her speed. He plots this on the chart and estimates which mine the vessel is approaching and the exact time when she will reach it. Allowing a definite time for transmitting the order by means of a telephone and for the officer at the other end to close the switch, he gives a signal when he thinks the vessel will be over the mine by the time it is fired. Naturally, operations of this kind can only be conducted satisfactorily and surely after a great deal of practice. Not only must the officers and men be drilled thoroughly in the work, but they must be entirely familiar with the system and with all the apparatus. Then, too, the handling of the electrical devices employed requires much skill. A marine cable such as must be employed is itself a more or less delicate object. It demands that it be treated with consideration. When joints are to be made, they must be made properly if satisfactory results are to follow. A job hastily done might suffice if the cables were to be used immediately, but a mine must be put down so that it can remain in perfect condition for weeks, possibly months, and yet always be ready for instant use.

"The second class of defensive work is in the training and firing of coast-defense guns. These are naturally large and powerful, yet they must be handled quickly and delicately. For this purpose the electric motor is being introduced in our coast defenses. The firing of the guns, in case of an attack, would, in general, be controlled from a station, somewhat in the same way as is the firing of the mines. The gunner would be given the range. He would then train his gun and would fire upon a signal from the station. Or the gun might even be fired by the commanding officer himself, who would naturally be at the fire-control station."

The department of electricity and mines for the United States Army is at the School of Submarine Defense, at Fort Totten, New York, and here selected graduates from the Military Academy at West Point are trained, both by reading and by practical work, in the construction and handling of the scientific mechanism of defense. The work includes not only the construction, placing, and explosion of mines, but also other electrical work, such as the handling of telephone communication, to which has been added the telautograph as a valuable auxiliary.

In addition to the training of artillery officers, instruction is also given to a certain number of men as expert electricians, their training including all kinds of shop work, so chosen as to render them skilled mechanics. The system is intended to render this branch of the service independent and self-reliant. The work of the school at Fort Totten is in addition to that conducted at the Artillery School at Fort Monroe, Virginia, this latter being intended to give all artillery officers that general knowledge of electricity which forms a portion of their equipment.

THE PANAMA CANAL.

A REVIEW OF THE SERIOUS OBJECTIONS TO THE CONSTRUCTION OF A SEA-LEVEL CANAL ACROSS THE ISTHMUS.

Major Cassius E. Gillette—Engineering News.

AT the present time, before the actual plans for the construction of the Panama canal have been completed it is of interest to consider everything which may have a bearing upon the building and operation of such a monumental work. Especially is it important that the difficulties which stand in the way of the construction of a sea-level cnannel be fully considered before the commission is committed to a plan which, while offering many attractions, is also open to serious objections. In a paper contributed to a recent issue of *Engineering News*, Major Cassius E. Gillette discusses the difficulties surrounding the sea-level scheme, and while the length of the paper prevents more than an abstract in these pages attention may be called to it as a valuable contribution to the literature of this great undertaking.

"Most reports and writings on the subject seem to take it for ganted that a sea-level canal is the only one that will fulfil this important condition, but such a conclusion is by no means borne out by the facts.

"Another seemingly off-hand conclusion that has been announced in nearly if not quite all of the reports of commissions and technical committees on the subject, is that a dam is not practicable at any site north of Bohio. Up to quite recently this pronouncement never appears to have been based on any borings, or other ascertained facts. The Chief Engineer and the Engineering Committee of the recent Commission came to the same conclusion as regards the proposed site at Gatun, this conclusion apparently being based on two borings.

"The advantages of a canal involving a high dam at Gatun are so great in the controlling elements of cost, time of construction, serviceableness and ease of enlargement, that the discovery of the best location and the devising of a dam that will successfully fit that location, are problems worthy of the most thorough study and research."

One of the most serious elements in the problem, Major Gillette points out, is the fact that the upper Chagres river is on the east of the canal line while the mouth is on the west. With a sea-level canal, therefore, the river flow must be taken into the canal, or the stream must be kept on the east side throughout, since it is wholly impracticable to carry the canal across the river on a viaduct, as has been done in the past with small canals crossing moderate streams.

"Another factor of vast importance, which, however, has received scant consideration in the past is that of sediment.

"The upper Chagres is doubtless a clear-water stream at low stages, but how much sediment it actually carries in floods seems never to have been measured. Its condition at present, too, is no guarantee of what it will be when the canal is opened. At present the tropical jungle is so thick that no matter how hard it rains the water only reaches the ground gradually, and flows off slowly through the mass of ground verdure, so that it can cause little or no erosion. When the French company had a large force at work, a large area of this jungle was cleared and put under cultivation to raise supplies for the workmen. The same thing will occur again when the canal force is augmented, and it may be expected to continue indefinitely, since passing ships and regular trade will doubtless furnish a market for all the bananas that can be raised as far up every stream as a canoe can be pushed. The country is made up of very steep slopes of volcanic soil easily eroded, and every stream that flows into the canal will become a menace to it. The evil could, of course, be lessened by buying the land and forbidding agriculture, but this would be expensive, and would lose to the world the agriculture of a very rich region, whose products would probably be quite valuable to passing ships.

"The problem of disposing of the sediment of all these streams, if a sea-level canal be adopted, is a serious one. The canal must occupy the bottom of the narrow valley and its water surface, if on the sea-level plan, must be no less than 55 feet below the present river surface, its bottom 35 or 40 feet lower still, while its banks are of easily eroded material. The sediment from even the smaller streams cannot be neglected. The Mandigo river, for instance, seems to have a drainage area of ten or fifteen square miles, and as it is on the Atlantic side of the divide, it must be subject at times to torrential floods."

After comparing the various lock level schemes, covering the 30 foot, 60 foot, 85 foot, and 97.5 foot levels, Major Gillette expresses himself as wholly favorable to the 100 foot level, with a dam situated at Gatun, unless the same dam can be placed further down stream.

"This is forbidden by the topography, the range of hills crossing at Gatun being the farthest one north that has sufficient height. Such a dam would give a lake having an area of at least 100 square miles, subject to very slight fluctuations, and capable of settling for ages all the mud that the streams would bring into it, and with no current of moment in its narrowest parts during the highest floods.

"In the dry season it would have for lockage, not only the flow of the Chagres proper, but its own immense storage, and the flow of the Trinidad, Gatuncillo, and other numerous tributaries located in the region of the heaviest rainfall. The dam could be built of the spoil from the Culebra cut, and its cost per ton would be only the cost of hauling it about 25 extra miles. It has to be loaded on the cars and hauled several miles and be dumped in any event. Moreover, dump grounds of the necessary capacity are not plentiful near Culebra, and it is quite probable that the later excavation may have to be hauled quite long distances.

"By such a dam all the expense of the nine miles of crooked canal between Bohio and Gatun would be saved, and replaced by the open navigation of a broad, deep lake. The Gatuncillo would be taken into this lake and all trouble from it removed.

"The saving in cost would be so great that the funds now authorized could probably cover also a canal through the summit cut deep enough and wide enough for all future needs, as well as a deep and wide straight entrance to the locks from Limon Bay, both conducing to safety and celerity of passage."

The general construction of the dam suggested by Major Gillette is the same as that proposed by the late George S. Morison for a dam at Bohio, being two rock dams placed about 2,000 feet apart, with an earth fill between. The strength of such a structure would be ample, while the seepage would be trifling, the dam forming really a filter bed 2,000 feet thick which would soon become entirely clogged.

"In this, as in all other suggested plans, the auxiliary works can all be readily completed before the Culebra cut. This plan, involving the least work on that cut, can therefore be completed the soonest. It should be noted that comparisons of time and cost of the various plans cannot be correctly based on the comparative amounts of excavation alone. As the cut is deepened, contingencies as to slides, congestion of plant, drainage, and increase in hardness and quantity of rock, must be allowed for. The removal of one yard of material below sea level for that type of canal, when the cost of pumping and the other above contingencies are counted, will doubtless amount to more than the cost of removing five or six yards for the 100-foot level canal, and the proportionate delays would make the matter of time much worse for the sea-level canal. It has been estimated that the latter can be completed in ten or twelve years. If so, the 100-foot level should be finished in less than five years.

"Under these circumstances it would appear proper to give the dam site at Gatun a much more thorough examination than has heretofore apparently been accorded it.

MECHANICAL EFFICIENCIES OF INTERNAL-COMBUSTION MOTORS.

METHODS OF DETERMINING THE DISTRIBUTIOOF THE INTERNAL RESISTANCE OF GAS ENGINES.

Rudolph Diesel—Verein Deutscher Ingenieure.

SEVERAL months ago we reviewed in these columns the discussion which took place in the Society of German Engineers upon the question of the proper method determining the mechanical efficiency of an internal-combustion motor, and since that time there have been some additional contributions to the discussion, which is by no means closed.

It may be recalled that the matter under discussion involves a fundamental definition, which, while it has never arisen in the case of the steam engine, and is of negligible importance in the case of small gas engines, becomes more important when the larger sizes of gas engines of modern design are considered. Ordinarily the mechanical efficiency of an engine is supposed to be the the ratio of the indicated power to the brake horse power, and it is intended to show the excellence of the mechanical performance of the machine as distinguished from its thermal performance. In the case of the steam engine the indicator diagram is supposed to show the total power developed in the cylinder, that is, the heat energy converted into mechanical energy, while the losses due to friction, etc., occur between the cylinder and the delivery belt.

In the case of the gas engine, however, the conditions are not altogether the same, and the result is that there is room for difference of opinion. In the ordinary four-cycle engine, the compression stroke takes place in the same cylinder as the power stroke, and its resistance appears on the indicator diagram. In the case of a two-cycle engine, however, the resistance of the compression pump is not apparent on the main indicator diagram, and if it is allowed to go in with the other internal resistances of the engine the mechanical efficiency will be correspondingly apparently increased.

If, however, indicator diagrams are taken from the compression pump, and its resistance deducted from the power developed in the power cylinder, the mechanical efficiency will be correspondingly lowered.

From the standpoint of the user of the engine no method can be satisfactory which does not include the real amount of power available for driving his useful machinery, and he is not interested in the power required to drive the pump, since it is not at his disposal for manufacturing purposes. It is, therefore, always desirable that the brake horse-power of an engine be stated. The designer, however, is interested in knowing how the internal resistances of an engine are distributed, and it is certainly desirable that uniformity of practice in this respect be observed, especially in connection with reports of tests and trials.

In a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure* there is given a further addition to the discussion of the question by Mr. Rudolf Diesel, who is well qualified by experience in the design and construction of internal-combustion motors to speak upon the subject. Mr. Diesel takes up the matter in the true scientific problem, not as a question for dispute, but rather a laboratory problem, to get at the truth. He believes that the question is largely one of definition, and that the uncertainty existing at present would be removed by the adoption, by some authoritative body, such as the Society of German Engineers, of determinate meanings for the various expressions employed. His nomenclature is as follows:

Indicated power; means the full power indicated in the working cylinder without any deductions.

Useful power; the bare amount of power wholly available for external work.

Effective power; the useful power, as defined above, plus the work required to operate the compression pumps.

Mechanical efficiency; the useful power divided by the indicated power, according to the above definitions.

Dynamic efficiency; the effective power divided by the indicated power.

Pump ratio; the result obtained by dividing the work required for the pump by the indicated power.

Friction ratio; the difference between unity and the dynamic efficiency.

It may seem rather elaborate to insist upon so many classifications, but these various elements are all there, and they all have to be taken into account, either in public tests or in private study and research, and hence it is most important that they should have recorded names and definitions, concerning which there can be no dispute, and to which authoritative reference may be made. In the course of the development of the Diesel motor a remarkably high thermal efficiency was attained at the start, while a considerable proportion of the power derived from the fuel was absorbed in the various mechanical resistances of the machine, partly owing, no doubt, to the high working pressures involved. As experience was gained in the construction and operation of the machine these internal resistances were materially diminished, and in the motors of more recent construction a much greater portion of the power developed in the cylinder is available for external work, so that Mr. Diesel knows very well the nature and magnitude of the internal resistance which the engineer encounters in such work.

Like many other disputes and discussions, differences of opinion arise when men are not talking about the same thing, and as soon as clear and comprehensive definitions of the terms included in the argument are adopted the differences naturally disappear. The engineering profession will do well to examine these definitions suggested by Mr. Diesel, and should they receive approval they may well be incorporated in the various codes for testing steam and gas engines.

It is a matter of interest to note that while this discussion has not actively arisen in connection with steam engine trials, the elements for the same differences exist as in the case of internal-cumbustion motors. Thus, in the case of the ordinary condensing engine, as it has been built since the days of Watt, the air pump has been driven by the engine itself, thus forming a resistance not materially different in nature from the compressing pump of the gas engine. In recent years, however, especially for large marine engines, it has not been unusual to find the air and circulating pumps operated independently, and this practice is also entering into stationary power-plant design. Unless the engine in the latter case is charged with the power required for these independent pumps, its mechanical efficiency, according to the usual definition, is not computed on the same basis as in the case of the engine in which the air pump is directly connected to the crank or cross-head. By using the broad definition suggested by Mr. Diesel, however, any uncertainty as to the meaning of the expressions will be removed, regardless of the kind of engine to which they may be applied.

THE GEOLOGY OF THE SIMPLON TUNNEL.

SCIENTIFIC DATA AND INFORMATION OBTAINED IN CONNECTION WITH THE LATEST PIERCING OF THE ALPS.

H. Schardt—Bulletin Technique de la Suisse Romande.

WE have repeatedly noticed the work upon the Simplon tunnel from its beginning until the meeting of the headings in February last, and have also examined the changes and modifications which its operation may make in the railway connections of central Europe. There is another side to this important work, however, which, while not directly connected with its engineering features, is really of much importance; that is, the additions which its construction has made to the general stock of information about the nature of rock formations and of water-courses in the interior of the Alps, and of similar mountain ranges. In a series of interesting articles in recent issues of the *Bulletin Technique de la Suisse Romande*, Professor H. Schardt gives a résumé of the scientific results of the piercing of the Simplon, from which we make an abstract.

Before the work upon the tunnel was begun the geology of the mountain was made the subject of careful study, with the object of determining, so far as possible, the nature of the strata through which the passage was to be made. The nature of the interior of the mountain was based upon the investigations of Bernard Studer in 1851; of Gerlach, in 1869; of Renevier, in 1878; and of Heim, Lory, and Taranvelli, down to 1882. These, however, were made in view of the construction of a tunnel at a high altitude, and when the present plan for a tunnel, with a maximum elevation of only 705 metres above sea level, was considered, it was thought advisable to have a later examination of the geology of the route. This work was undertaken by Professor Schardt himself, in 1890, and a geological map, together with a profile, showing the supposed formation of the interior of Monte Leone, was prepared.

As the work on the tunnel proceeded it became evident that the nature and position of the strata were materially different from what had been inferred, and the successive modifications in the profile along the line of the tunnel are very clearly shown in Professor Schardt's articles. The actual perforation of the tunnel revealed the existence of remarkable plications and reversals in the older strata beneath the recent ones. The result was the appearance in the tunnel of horizontal strata, where it had been supposed that the layers of rock would have been almost vertical, this causing increased difficulty in the working, owing to the fact that the natural roof ceased to be self-sustaining. There were four distinct formations encountered in the tunnel; the Jura-Trias formation, consisting of clayey, micaceous, and calcareous schists; the Trias, white dolomite, gray calcareous dolomite, and quartzite; Crystalline Schists, considered to be paleozoic, probably partly triassic or metamorphic Jurassic; and finally the primitive gneiss, the gneiss of Antigorio, and schistose gneiss of Monte Leone.

Under the enormous pressure these rocks appeared transformed from their ordinary characteristics. The lustrous schists resembled mica-schists or micaceous calc-schists; the triassic quartzites had the appearance of gneiss; rocks really almost identical appeared different, while those quite different resembled each other. In this respect the result in the Simplon was very different from that of the Saint Gothard. In the piercing of the latter tunnel the profile constructed by M. von Fritsch was almost wholly verified by the completed work, while in the case of the Simplon the results differed greatly from the prediction.

In addition to the unexpected geological conditions developed by the boring of the Simplon tunnel there appeared the remarkable irruptions of both hot and cold water.

It was to be expected that a moderate number of springs would be encountered in the course of the work, in view of the existence of various water courses upon the surface. The enormous volume of water which appeared in the heart of the mountain, was entirely unexpected, however, and its origin is even yet unaccounted for. In many instances the temperature of the discharged water was higher than that of the rock from which it flowed, while in other cases the temperatures of the water and the rock were about the same. The flow of cold water, however, was greater than the discharge of the hot springs, the total volume of water at the time of maximum flow aggregaing about 1,200 litres from all the hot springs, or about 42 cubic feet per second. An interesting feature about these springs is the fact that they appear to have an annual periodicity, both as to volume and temperature. The cold springs attain their highest temperature, about 18 degrees Centigrade, in the month of April, falling to 14 degrees in July, and rising again during the autumn and winter. The greatest flow occurs in July and the minimum in April, the maximum discharge being 30 to 40 per cent. greater than the minimum, and entirely independent of any surface conditions. The water from these springs is highly charged with sulphate of lime from the deposits of gypsum and anhydrite occurring in the triassic marbles, the average content being one gramme of gypsum per litre of water. Professor Schardt calls attention to the fact that a discharge of 1,000 litres of water per second, with a content of one gramme per litre of sulphate of lime, corresponds to a weight of 31,530 metric tons of gypsum per year, dissolved out of the heart of the mountain, a noteworthy example of the eroding power of water flow in the earth.

The question of the internal temperature of the mountain is also considered by Professor Schardt. Assuming the increased temperature in the interior to depend upon the height of the mass above, various computations of the probable temperature in the interior of Monte Leone were made in advance of the boring of the tunnel. Thus Stockalper, the engineer-in-chief of the northern end of the Saint Gothard tunnel, computed that the heat would reach 36 degrees centigrade, under the Furggenbaumgrat, where the altitude above reached 2,050 metres. Strapff, the geologist of the St. Gothard, however, maintained that the internal temperature would reach 47 degrees in a tunnel pierced at the level of Brieg, and advised that the mountain be pierced at a level of 500 metres higher. As a matter of fact, the temperature in the Simplon tunnel for a length of about two kilometers in the middle of the rocks remains at 50 degrees centigrade, or 122 degrees F. The actual temperature of the interior of the tunnel is maintained at a bearable degree, the above figures being obtained by the insertion of a thermometer into bore holes in the rocks for the purpose of obtaining the true heat. By the spraying of cold water, and by a powerful system of ventilation through the auxiliary tunnel, the temperature of its atmosphere may be well controlled.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Arched Girders with Elastic Abutments (Bogenträger mit Elastisch Eingespannten Kämpfern). Adolf Francke. A mathematical investigation, computing the stresses for a number of cases. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 20, 1905. No. 70958 D.

Empirical Formulas for Reinforced Arches. Daniel B. Luten. Gives rules governing the design, with views and sections of bridges designed in accordance, and describes their erection. 1000 w. Cement—July, 1905. No. 70775 C.

Race Street Concrete Arch, Ypsilanti, Michigan. W. L. Luten. Illustrates and describes the construction. 800 w. Cement—July, 1905. No. 70771 C.

The Connecticut Avenue Concrete Arch Bridge, Washington, D. C. An illustrated description of progress in the erection. 900 w. Eng Rec—July 8, 1905. No. [illegible]

Bascule.

Bascule Bridge of the New Orleans Terminal Company. Brief illustrated description of a recently completed bridge across New Basin Canal. 500 w. R R Gaz—Vol. XXXIX. No. 4. No. 71074.

Erection.

Cantilever Erection of Simple Riveted Railroad Spans. Illustrates and describes the methods of erection used on the extension of the Western Maryland Railroad. 3000 w. Eng Rec—July 15, 1905. No. 70781.

Floors.

Reinforced Concrete for Bridge Floors (Betoneisentragwerke für Strassenbrücken). Anton Kraupa. Computations of strength for various distributions of load; with details of construction. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—June 10, 1905. No. 70961 D.

Highway Bridge.

Highway Bridge over the Wabash at Terre Haute Indiana. Illustrated detailed description of this new bridge and the methods of erection. It is composed of 6 spans of 120 ft., and one of 75 ft., in the center. 1200 w. R R Gaz—Vol. XXXIX., No. 1. No. 70676.

Manhattan.

Cables for the Manhattan Bridge. Gives drawings showing some of the details of the cable connections and suspenders, with information from the specifications. 1300 w. R R Gaz—Vol. XXXIX. No. 4. No. 71073.

Reconstruction.

The Tennessee River Bridge of the Illinois Central. H. W. Parkhurst. Illustrated description of a new bridge constructed on a new site, the line being diverted to take out nearly 120 deg. of curvature, and of the methods of erection. 3300 w. R R Gaz—Vol. XXXIX. No. 2. No. 70770.

Thebes.

The Thebes Bridge Superstructure. Brief illustrated description of the steel superstructure of one of the largest bridges across the Mississippi River. 1500 w. Eng Rec—July 22, 1905. No. 71022.

Viaducts.

The Newark Viaducts of the Lackawanna Railroad. Illustrated detailed description of work made necessary in the elimination of grade crossings of the D. L. & W. R. R. 1800 w. Eng Rec—July 22, 1905. No. 71024.

Vierendeel System.

The Vierendeel System of Metal Bridges (Les Ponts Métalliques, System Vierendeel). A Morizot. Describing especially the bridge at Avelghem, Belgium, of a plate-girder type, pierced with rectangular openings. 2500 w. 1 plate. Génie Civil—June 17, 1905. No. 70915 D.

Zambesi.

Bridge Over the River Zambesi at Victoria Falls, Rhodesia. An illustrated detailed account of the design and erection of this remarkable bridge at Victoria Falls. 4000 w. Engng—July 7, 1905. Serial. 1st part. No. 70789 A.

Completion of Victoria Falls Bridge. Gives interesting illustrations of this great engineering work in Central Africa, with some facts about the Cape-to-Cairo railroad and the methods of erection of the bridge. 2000 w. Sci Am—July 22, 1905. No. 70834.

CONSTRUCTION.

Building Details.

Column and Girder Details in a Loft Building. Brief illustrated description of details of a ten-story and basement building in New York, with a statement of the advantages claimed by the designers. 1000 w. Eng Rec—July 1, 1905. No. 70602.

Heavy Plate Girders in the Bellevue-Stratford Hotel Extension. Gives an illustrated description of unusual construction, made in order to secure an unobstructed 60 x 80 ft. floor area in a ballroom. 800 w. Eng Rec—July 15, 1905. No. 70783.

Coffer-Dams.

Construction of Coffer-Dams. Thomas P. Roberts. A brief description of cofferdam construction, with general discussion. 5000 w. Pro Engrs' Soc of W Penn—July, 1905. No. 71103 D.

Columns.

The Strength of Columns. Prof. W. E. Lilly. Read before the Inst. of Mech. Engrs. An account of experiments carried out to determine the conditions under which failure takes place either by primary or secondary flexure, and to obtain information as to the values of the areas and radii of the gyration of economic cross-sections. 1500 w. Mech Engr—July 8, 1905. Serial. 1st part. No. 70787 A.

Cost Keeping.

See Industrial Economy.

Dams.

Failure of Lake Avalon Dam, near Carlsbad, N. M. E. C. Murphy. Describes the construction and gives a brief account of the two failures of this dam, discussing the cause of the second failure. Ills. 1000 w. Eng News—July 6, 1905. No. 70613.

On the Distribution of Shearing Stress in Masonry Dams. Prof. W. C. Unwin. An examination of shearing stress in dams of various forms. 900 w. Engng—June 30, 1905. No. 70721 A.

On the Stability of Masonry Dams. Karl Pearson. A reply to critical papers by Prof. W. C. Unwin. 2500 w. Engng—July 14, 1905. No. 70893 A.

Pile Foundations for Movable Dam, at McMechen, W. Va., with Method of Calculation. Gilbert S. Walker. Briefly describes the four principal types of foundations which were considered, and gives details of the type adopted. Ills. 2400 w. Eng News—July 27, 1905. No. 71068.

Dome.

The Construction of a Stone Dome. James S. Boyd. Read before the Glasgow and W. of Scotland Tech. Col. Archt. Crafts Soc. Illustrates and describes the constructional and practical part of the work connected with a dome of moderate size, and the principles of stone dome construction. 2800 w. Am Archt—July 22, 1905. No. 70886.

Excavation.

Methods of Subaqueous Rock Excavation, Buffalo Harbor, N. Y. Brief illustrated article describing the plant used in this work of improving the Lake Erie entrance to Black Rock Harbor and Erie Basin, N. Y. 1000 w. Eng News—July 6, 1905. No. 70611.

Fireproof.

Uniform Building Laws. Gives the recommendations of the National Board of Fire Underwriters for the construction of fireproof buildings. 5000 w. Ins Engng—July, 1905. No. 70798 C.

Foundations.

Steel Sheet Piling to Secure an Old Foundation. Describes methods adopted in building an extension to the Tribune Building, New York City, where the foundations were to be carried 7½ feet below the footings of the present building. Ills. 800 w. Eng Rec—July 15, 1905. No. 70785.

Reinforced Concrete.

Bending Moments in Continuous Reinforced Concrete Beams. Translated from *Beton u. Eisen*. O. Gottschalk. An interesting discussion of the bending moments in a continuous beam over three supports, especially at the mid-support. 1000 w. Cement—July, 1905. No. 70773 C.

European Reinforced Concrete Piles. Abstract of a paper by A. R. Galbraith, presented to the Assn. of Munic. & Co. Engrs. The methods of manufacture, the driving, and the various types of molded piles are discussed. 2500 w. Eng Rec—July 22, 1905. No. 71023.

Ferro-Concrete in Belgium. Ed Noaillon. Read before the Inst. of Mech. Engrs., at Liége. States the properties of this material, and describes applications made of it in Belgium. Ills. 8000 w. Engng—June 23, 1905. No. 70640 A.

Reinforced Concrete Bridge Floors, Culverts and Abutments, Wabash, R. R. Illustrated description of approved construction. 1600 w. Ry and Engng Rev—July 15, 1905. No. 70768.

Reinforced Concrete Chapel Building, U. S. Naval Academy, Annapolis, Md. An illustrated description of the reinforced concrete work on this new chapel building. 1800 w. Eng News—July 13, 1905. No. 70739.

Reinforced Concrete Fence Posts Molded in the Ground. Describes the materials used and the construction of this form of post. Ills. 1000 w. Eng News—July 20, 1905. No. 70828.

Reinforced Concrete—Some of Its Principles, with Practical Illustrations. Walter Loring Webb. Discusses some satisfactory uses of this material, its economy, effect of elastic limit of the steel, stresses, expansion joints, steel-concrete tanks, protection of steel from rusting by concrete, etc. General discussion. 8000 w. Pro Engrs' Club of Phila—July, 1905. No. 70865 D.

Tests of the Efficiency of Vertical Stirrups in Reinforced Concrete Beams. An illustrated report of tests made at the yards of the Bush Terminal Co., Brooklyn, N. Y., to determine the behavior of beams provided with vertical stirrups in place of inclined metal. 1500 w. Eng News—July 6, 1905. No. 70612.

See Civil Engineering, Bridges.

Roof Truss.

The Numerical Determination of the Maximum Stresses in a Roof Truss (Zeichnerische Bestimmung der Grossten Strebenkrafte eines Fachwerkbalkenträgers). Paul Neumann. An application of the graphical analysis, showing the practical details of computation. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 24, 1905. No. 70963 D.

Tunnels.

The Applications of Electricity in Tunneling (Elektrotechnische Aufgaben im Tunnelbau). Arthur Hruschka. A discussion of the increasing applications of electric power for ventilators, rock drills, traction, and other departments of tunnel construction work. Three articles. 6000 w. Zeitschr f Elektrotechnik—May 21, 28, June 4, 1905. No. 70683 each D.

The Chicago Tunnels. Illustrates and describes the 30 miles of underground passages built for carrying telephone cables, and now to be operated for the carriage of mails, parcels and goods. 1000 w. Engr, Lond—July 14, 1905. Serial. 1st part. No. 70891 A.

The Scientific Results of the Piercing of the Simplon Tunnel (Les Resultats Scientifiques du Percement du Tunnel du Simplon). H. Schardt. A complete study of the geological and physical information gained in the course of the boring of the tunnel, from a scientific viewpoint. Serial. Part I. 3000 w. Bull Tech de la Suisse Romande—May 25, 1905. No. 70999 D.

Tunnel Boring and Mountain Pressures (Tunnelbau und Gebirgsdruck). C. J. Wagner. An examination of the influence of rock pressures in mountains upon the difficulty of tunneling. Serial. Part I. 2000 w. Schweiz Bauzeitung—July 1, 1905. No. 70956 B.

Underpinning.

Underpinning a 70 ft. Wall Without Temporary Supports. Brief description of methods used in building the addition to the Tribune Building, New York City. Ills. 1500 w. Eng Rec—July 22, 1905. No. 71018.

Walls.

Retaining Walls (Stutzwande) Zdenko Ritter von Limbeck. Discussing especially the peculiar advantages of properly designed reinforced concrete construction for retaining walls to resist the thrust of earth pressure. 2000 w. 1 Plate. Oesterr Wochenschr f d Oeffent Baudienst—July 8, 1905. No. 70965 D.

MATERIALS OF CONSTRUCTION.

Cement.

Low-pulling Portland Cements. W. A. Aiken. Read before the Am. Soc. of Test. Materials. Gives information obtained in testing cement for the N. Y. subway construction. 1200 w. Eng Rec—July 8, 1905. No. 70700.

The Cement Industry in the United States (L'Industrie du Ciment aux Etats Unis). George P. Roux. A review of the development of the manufacture of Portland cement in America, from a French viewpoint. 6000 w. Mem Soc Ing Civ de France—May, 1905. No. 70933 G.

The Development of the Portland Cement Industry (Le Progres de l'Industrie du Ciment Portland). E. Candlot. An historical review of the cement industry, with especial reference to the development of the rotary kiln. 4000 w. Mem Soc Ing Civ de France—May, 1905. No. 70934 G.

Concrete.

Concrete. Brysson Cunningham. Considers its composition, giving a detailed discussion of its preparation and uses. Ills. 3500 w. Sci Am Sup—July 29, 1905. No. 71083.

Investigation of the Effect of Heat Upon the Crushing Strength and Elastic Properties of Concrete. Ira H. Woolson. Read before the Am. Soc. for Test. Materials. Reports investigation made of this subject with details of experiments. Ills. 3800 w. Eng News—July 13, 1905. No. 70712.

The Fire Resistance of Different Concretes. Reports the results of tests made by the Committee on Cement for Building Construction of the National Fire Protection Association. 1700 w. Eng Rec—July 22, 1905. No. 71021.

Paint.

Proper Methods in Conducting Painting Tests. Gustave W. Thompson. Read before the Am. Soc. for Test. Materials. A discussion of painting tests made on paints used for the purpose of producing a desired finish of appearance. 3300 w. Eng Rec—July 15, 1905. No. 70782.

Stresses.

The Permissible Stresses upon a Material Subjected to Forces Acting in Several Directions (Die Zulässige Anstrengung eines Materials bei Belastung nach Mehreren Richtungen). H. Wehage. An examination of the stresses caused by multiple loading, with formulas for determining the maximum stress. 3000 w. Zeitschr d Ver Deutscher Ing—July 1, 1905. No. 70913 D.

Testing.

The Testing Engineer. Presidential address by Dr. C. B. Dudley before the American Society for Testing Materials. Gives an analysis of the scope and field of the testing engineer, and remarks on the preparation needed. 4500 w. Eng Rec—July 8, 1905. No. 70697.

Timber.

Tests of Structural Timber (Essais des Bois de Construction). J. Malette. A discussion of the common defects in timber, and the best methods of testing according to the conditions of usage. 3000 w. Revue Technique—April 25, 1905. No. 70930 D.

Torsion.

The Work of Deformation in Torsion (Zur Frage: Formänderungsarbeit bei Torsion). M. T. Huber. A criticism of the theory of Professor Zschetzsche, with a reply by the latter. 4000 w. Oesterr Wochenschr f d Oeffent Baudienst—June 3, 1905. No. 70960 D.

MEASUREMENT.

Mensuration.

A Problem in the Storage of Granular and Lump Material. W. E. Hunter and J. S. Myers. Gives diagrams for computing the contents of conical piles of material enclosed by walls at the base, with notes. 1000 w. Eng News—July 27, 1905. No. 71065.

Mine Surveying.

See Mining and Metallurgy, Mining.

Recorder.

An Electrical Long Distance Water-Level Indicator. Illustrates and describes an apparatus designed by Hans Baumeister, of Vienna, for recording the water level of a river, at a distance. 1600 w. Sci Am Sup—July 22, 1905. No. 70837.

Surveying.

Methods of Filing Records in a City Surveyor's Office. Fred Gabelman. Describes a system of indexing developed, which enabled information desired to be quickly available. 2500 w. Eng News—July 20, 1905. No. 70826.

Stereoscopic Vision Applied to Surveying. E. F. Northrup. Brief description of the "Telemeter" and the "Stereocomparator," two instruments making use of the principle of stereoscopic vision. Discussion. 1800 w. Pro Engrs' Club of Phila—July, 1905. No. 70868 D.

Wind Pressure.

The Danger of Wind Pressure in Railway Operation (Die Gefahr des Sturmwindes im Eisenbahnverkehr). Anton Syha. An examination of the influence of wind pressure upon trains, describing a recording gauge for measuring wind pressure. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—June 17, 1905. No. 70962 D.

MUNICIPAL.

Electric Stations.

See Electrical Engineering, Generating Stations.

Highways.

Highways of France. William Ballantine. Reports an inspection of the boulevards and avenues of Paris and roads of the surrounding districts. 3500 w. Munic Jour of Engr—July, 1905. Serial. 1st part. No. 70569 C.

Methods of Preventing Dust on Roads (Moyens de Combattre la Poussière sur les Routes). Dr. Guglielminetti. Describing especially the appliances used for sprinkling the roads between Nice, Monte Carlo and Mentone. 3000 w. Génie Civil—June 24, 1905. No. 70917 D.

The Need of Systematic Instruction in Highway Engineering. A. N. Johnson. Read before the Soc for the Promotion of Engng. Education. Remarks on the large sums of money being expended for the improvement of highways, and the need of experienced men for supervision. 1500 w. Eng Rec—July 8, 1905. No. 70699.

Manila.

The Engineering Development of Manila Under American Dominion. Robt. G. Dieck. An account of the many improvements since the city has been under American control. Also discussion. 4000 w. Pro Engrs' Club of Phila—July, 1905. No. 70864 D.

Office-Buildings.

Sanitation of Office Buildings. Henry Leffmann. A condemnation of some conditions often found in these buildings. General discussion. 4800 w. Pro Engrs' Club of Phila—July, 1905. No. 70866 D.

Pavements.

Wood Paving. T. H. Scott. Information about the use of wood paving in English cities. 2000 w. Munic Jour & Engr—July, 1905. No. 70568 C.

Pipe Tunnel.

Pipe Tunnel at Dover St. Bridge, Boston. Frederic I. Winslow. Brief illustrated description of this work. 700 w. Eng News—July 13, 1905. No. 70744.

Refuse.

City Refuse as Fuel in Electric Plants. George E. Walsh. Discusses what has been accomplished in England and recent improvements that have been introduced. 2800 w. Am Elect'n—July, 1905. No. 70605.

Sewage-Disposal.

Sewage Disposal at Elmhurst, N. Y. Illustrates and describes a recently completed plant on Long Island, designed to treat 1,000,000 gallons of sewage per day by sedimentation and intermittent sand filtration. 2200 w. Eng Rec—July 22, 1905. No. 71017.

Sewage Disposal at Hampton, England. An explanation of these works, taken from *The Surveyor.* 2200 w. Eng Rec—July 22, 1905. No. 71019.

Sewage Disposal. Morrell Vrooman. Digest of a paper read before the League of Am. Municipalities. Briefly discusses various methods of disposal. 3500 w. Munic Jour and Engr—July, 1905. No. 70570 C.

The Bacteriological Treatment of Sewage. F. Herbert Snow. Reviews the work of investigators in this field, giving a summary of what is now known about bacterial treatment of sewage by the various processes. Also general discussion. 12500 w. Pro Engrs' Club of Phila—July, 1905 No. 70869 D.

Sewers.

The Efficiency of the New Haven Sewerage System. Frederick Jackson. From a paper before the Conn. Assn. of Civ. Engrs. Explains the method used to determine the efficiency of this sewerage system. 2500 w. Munic Engng—July, 1905. No. 70803 C.

The Proportioning of Municipal Sewerage Plants (Die Berechnung Städtischer Kanalisationsanlagen). H. Heyd. A general discussion of the provision for rainfalls of various force and duration, illustrated by the sewer system of the City of Darmstadt. 3000 w. 2 plates. Gesundheits Ingenieur—July 16, 1905. No. 70907 D.

Tables for the Computation of Sewers

and Drain Pipes (Vereinfachte Tabellen zur Berechnung von Kanal oder Rohrquerschnitten für Kanalisationsanlagen). Max Schendera. Tables for circular pipes and for egg-shaped sewers, with diagrams for the determination of coefficients. 3500 w. Gesundheits Ingenieur—June 30, 1905. No. 70996 B.

Snow.

A Novel Snow Compressing Machine. Illustrates and describes a machine for dealing with snow in city streets. 1400 w. Eng News—July 27, 1905. No. 71067.

Surveying.

See Civil Engineering, Measurement.

WATER SUPPLY.

Filtration.

A Modern Filtration Plant. James G. Fernald. Illustrated description of the plant now under construction at Washington, D. C., the second largest in the world. 2000 w. Sci Am—July 29, 1905. No. 71080.

Operation of Sand Filters of Indianapolis Water-Works. W. C. Mabee. Extract from a paper read before the Indianapolis Technical Club. Illustrates and describes the method of operating these filters. 2500 w. Munic Engng—July, 1905. No. 70862 C.

South Bethlehem Filtration Plant. P. A. Maignen. Digest of a paper read before the Am. W. Wks. Assn. Illustrated general description of an improved slow sand system and its operation. 2500 w. Munic Jour and Engr—July, 1905. No. 70567 C.

Fire Systems.

High Pressure Fire Systems. Everett U. Crosby. Committee report adopted by the National Fire Protection Association. 4500 w. Ins Engng—July, 1905. No. 70799 C.

Irrigation.

The Industrial West. An illustrated article explaining how oil fuel has made irrigation possible, describing the irrigation wells, the manufacture of pumps and engines for the industry, etc. 3000 w. Am Mach—Vol. 28. No. 30. No. 71070.

Madrid.

The Water-Works Catastrophe in Madrid. T. A. Greenhill. An illustrated account of the failure of the reinforced concrete covering of a service reservoir. 2000 w. Eng Rec—July 22, 1905. No. 71016.

Pumping.

The Selection of Water-Works Pumping Machinery. Nicholas S. Hill, jr. A discussion of this subject from the standpoint of the purchaser. The present number gives an outline indicating the essential features to be covered by a specification. 5000 w. Eng Rec—July 8, 1905. Serial 1st part. No. 70666.

Purification.

Water Purification at South Bethlehem, Pa. Illustrated description of the filtration. 3800 w. Eng. Rec—July 15, 1905. No. 70780.

Rainfall.

Rainfall and Run Off (Regenabfluss und Abflussverzögerung). W. Krawinkel. A study of the surface and underground run-off for various conditions, with data for the proportions of sewers and drainage channels. Two articles. 4500 w. Gesundheits-Ingenieur—May 10, June 10, 1905. No. 70994 each B.

Springs.

Artificial Fountain and Geyser Springs. Myron L. Fuller. Describes the methods of constructing fountain springs and geyser springs, illustrating types. 1200 w. Sci Am—July 22, 1905. No. 70833.

Supply.

Shall We All Die of Thirst? J. E. Whitby. Remarks on the future outlook for the water supply; showing that the waters of the earth are drying up, and discussing briefly the causes, and the possible remedy. 1100 w. Sci Am Sup—July 22, 1905. No. 70839.

Water Analysis.

Progress in Standardization of Water Analysis in the United States. Information from the final report of the Committee of the American Public Health Assn., outlining the new requirements for the water analyst, and the best practice in America. 1800 w. Eng Rec—July 8, 1905. No. 70695.

WATERWAYS AND HARBORS.

Backwater.

The Computation of Backwater Curves (Beitrag zur Berechnung von Staukurven). Bretislav Tolman. An examination of the various formulas for computing the extent to which water is backed up by obstructions in a stream, compared with actual results on the Moldau at Prague. Two articles. 8000 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—July 1, 8, 1905. No. 70964 each D.

Canal Haulage.

Modern Electric Canal Haulage. An illustrated article describing the electric canal haulage locomotive tried on the Teltow Canal, and other systems of electric canal haulage. 2000 w. Mod Mach—July, 1905. No. 70562.

Canal Lift.

The Electric Portion of the Prize Canal Lift Project (Der Elektrische Teil des Preisgekrönten Schiffshebewerk Projektes "Universell"). Josef Rothmüller. Details of the electrical hoisting machinery for the inclined plane lift proposed for the Danube-Moldau Canal. Serial. Part I.

3000 w. Zeitschr d Oesterr Ing u Arch Ver—June 30, 1905. No. 70929 D.

Crane.

10-Ton Electric Travelling Jib-Crane. Illustrated detailed description of a jib-crane shown at the Liége Exhibition, and constructed for the Maritime Station, Brussels. 800 w. Engng—June 30, 1905. No. 70723 A.

Dry Docks.

The Comparative Merits of Floating Docks and Graving Docks. From the report of the Massachusetts State Board of Harbor and Land Commissioners concerning the relative merits of graving docks and floating docks. 4500 w. Eng News—July 20, 1905. No. 70830.

Nile.

Sir William Preece and "The Navigation of the Nile." Sir Hanbury Brown. A review of a paper read 1st of February, 1905, before the Society of Arts in London, with a defence of the writer of it. 3300 w. Engr, Lond—July 14, 1905. No. 70889 A.

Panama.

The Panama Canal: Some Serious Objections to the Sea Level Plan. Cassius E. Gillette. Proposes a lock canal with a dam at Gatun, pointing out its advantages. Discusses the question of the disposition of floods and silt from the streams in the Chagres Valley. Ills. 6000 w. Eng News—July 27, 1905. No. 71061.

The Present Status of the Panama Canal. C. F. Z. Caracristi. An able discussion of the causes of delay in this work, and of the resignation of the chief engineer, the sanitation of the isthmus, and related topics. 4000 w. Mfrs Rec—July 13, 1905. No. 70720.

Sea-Wall Failure.

Failure of a Concrete Sea-wall. George W. Blodgett. An illustrated account of the breaks in the sea-wall at Hull, Mass., describing the conditions and the cause of the two breaks. 900 w. R R Gaz—Vol. XXXIX. No. 3. No. 70848.

Sounding.

A Trachometric Sounding Apparatus (Der Sondiertachygraph). Rudolf Reich. A description of the Reich-Ganser Stadia apparatus for the rapid conduct of hydrographic sounding and surveying. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—June 16, 23, 1905. No. 70928 each D.

MISCELLANY.

Reclamation.

Reclaiming of Bouldin Island, Cal. John A. Yeatman. Illustrated account of a very difficult piece of reclamation work. 2000 w. Min & Sci Pr—July 8, 1905. No. 70777.

Sanitation.

Army Sanitation in Manchuria. A review of the address by Major Louis Livingston Seaman before the Committee on Military Affairs of the U. S. House of Representatives, concerning army sanitation, and the great success of Japanese methods. 2200 w. Sci Am Sup—July 8, 1905. No. 70623.

ELECTRICAL ENGINEERING

COMMUNICATION.

Combined Service.

Combined Telephony and Telegraphy. Samuel G. McMeen. Presented at the convention of the Nat. Inter-State Telephone Assn. Explains the advantages of combined working, and the plans of arrangement for different classes of service. 2500 w. Elec Rev, N. Y.—July 8, 1905. No. 70665.

Exchanges.

Terminals and Distribution Boards in Telephone Exchanges. Arthur V. Abbott. An illustrated article discussing methods now considered the best practice. 3300 w. Elec Wld & Engr—July 22, 1905. No. 71048.

Relay.

An Improved Relay System for Continuous Currents, with Mechanical Locking Device (Ueber eine Neue Ruhestrom Translation mit Mechanischer Verriegelung der Relaishebel). J. Jakisch. Details of the relay system in operation on the Austrian telegraph lines. 2000 w. Zeitschr f Elektrotechnik—May 21, 1905. No. 70984 D.

Space Telegraphy.

Design of the Telefunken System. A. Frederick Collins. Gives additional interesting features relating to this system. 2200 w. Elec Wld & Engr—July 22, 1905. No. 71046.

Present Problems in Space Telegraphy (I Problemi Attuali della Radiotelegrafia). Vincenzo Leone. A review of the progress made during the past year, with especial reference to the applications of space telegraphy to marine and naval service. 7500 w. Rivista Maritima—June, 1905. No. 71052 G.

Some Problems in the Wireless Transmission of Signals. L. H. Walter. The present article discusses the present standpoint of the transmission of energy; the improving of the transmitter efficiency, etc. 1000 w. Elec Mag—June 27, 1905. Serial. 1st part. No. 70812 A.

Stone Wireless Telegraph System. A description covering recent developments, and dealing especially with the practical features of the apparatus. 1700 w. Elec Wld & Engr—July 8, 1905. No. 70693.

The Murgas System of Wireless Telegraphy. Illustrates and describes this system which is in operation between Wilkesbarre and Scranton, Penn., discussing the difficulties that were overcome. apparatus. 900 w. Sci Am—July 8, 1905. No. 70760.

Telautograph.

The Improved Gruhn Telautograph. Dr. Alfred Gradenwitz. An illustrated description of great improvements in this apparatus. 900 w. Sci Am—July 8, 1905. No. 70619.

Telephony.

The Evolution of the Telephone. W. H. Sharp. Reviews the history of telephone evolution, leading to A. G. Bell's telephone "improvements" in 1876. 5000 w. Sci Am Sup—July 15, 1905. No. 70750.

War Telephones.

The Use of the Telephone by the Japanese Army at the Battle of Mukden. M. C. Sullivan. An account of the skilful use made of the telephone in handling the Japanese army. 1500 w. Elec Rev, N. Y.—July 1, 1905. No. 70572.

Waves.

Electrical Waves and the Behavior of Long-distance Transmission in Lines. W. S. Franklin. Develops Maxwell's mechanical conceptions of electromagnetism and applies them to the discussion of electromagnetic waves. Also discusses wave distortion on telephone lines; the effect of line resistance and line leackage, etc. Ills. 5000 w. Jour Fr Inst—July, 1905. No. 70843 D.

DISTRIBUTION.

Cables.

The Heating of Triple Underground Cables (Ueber die Erwarmung von Versellten Drefachkabeln in Erde Verlegt). Paul Humann. With tables and diagrams for computing the rise in temperature; comparing the computed results with experimental determinations. 4500 w. Elektrotech Zeitschr—June 8, 1905. No. 70970 B.

Conduits.

Underground and Submarine Conduits for Electric Wires. D. A. Harrington. An illustrated article, describing the solid system, and the drawing in system, and discussing the materials used, methods of construction, etc. 7000 w. Jour Assn of Engng Socs—May, 1905. No. 71091 C.

Converters.

How to start Rotary Converters. Arthur Wagner. Gives diagrams showing the connections for different methods employed, together with the various conditions under which they operate. 1000 w. Elec Jour—July, 1905. Serial. 1st part. No. 70810.

Extensions.

Extensions to Outlying Areas. A. B. Mountain. Read before the Incor. Munic. Elec. Assn. Considers the extensions of electrical mains beyond the municipal boundary barely remunerative. General discussion. 3000 w. Elect'n, Lond—June 30, 1905. No. 70713 A.

Rectifiers.

Mercury Arc Rectifiers. P. D. Wagoner. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Describes a rectifier consisting of a mercury-vapor arc., enclosed in an exhausted vessel, and its operation. 900 w. Engr, U. S. A.—July 1, 1905. No. 70591 C.

The Mercury Vapor Converter. P. H. Thomas. Explains the operation of the apparatus, and gives some of its applications. Ills. 1700 w. Elec Jour—July, 1905. No. 70807.

Switch Gear.

Colliery and Mining Switch Gear for High and Low Tension Alternating-Current Service. A. M. Randolph. Illustrates and describes a special line of switch gear developed by the British Westinghouse Co. 1500 w. Ir & Coal Trds Rev—June 30, 1905. Serial. 1st part. No. 70730 A.

Transformers.

Operation of Transformers at Varying Frequencies and Voltages. M. A. Sammett. Read before the Can. Elec. Assn. Considers characteristics expressing the effect of varying frequency and variable voltage on transformer operation. 5000 w. Elec Rev, N. Y.—July 8, 1905. No. 70664.

ELECTRO-CHEMISTRY.

Address.

The Electrochemical Industries of Niagara Falls. A review of the address of Francis A. J. FitzGerald at the Buffalo meeting of the Am. Chem. Soc. Discusses the electro-chemical products made at Niagara Falls. 3300 w. Elec-Chem & Met Ind—July, 1905. No. 70667 C.

Agriculture.

Agricultural Electro-Chemistry. Abstract of a lecture by M. Guarini, on the different applications of electro-chemistry to agriculture and to the industries connected therewith. 2000 w. Sci Am Sup—July 22, 1905. No. 70838.

Electric Furnaces.

Five Thousand Degress of Heat. Describes the action of the electric furnace and some of the uses to which it has been applied, especially the making of gems. Illustrates and describes the making of diamonds. 2000 w. Sci Am—July 29, 1905. No. 71079.

Electric Smelting.

The Present Status of the Electric Smelting of Iron and Steel (Ueber den Gegenwärtigen Stand der Elektrischen Eisen und Stahlerzengung). Dr. W. Borchers. A general review of the furnaces which have been actually employed in electric smelting, with data as to the cost of production. 3500 w. Stahl u Eisen—June 1, 1905. No. 70937 D.

Electrolysis.

The Relation Between Electrolytic Action and the Temperature of Electrodes (Uber Beziehungen Zwischen Electrolytischen Vorgangen und der Elektrodentemperatur). Wilhelm Moldenhauer. An exhaustive review of experiments upon a great variety of solutions at different temperatures. 10,000 w. Zeitschr f Elektrochemie—May 26, 1905. No. 70991 D.

Electro-Metallurgy.

The Commercial Development of Electro-Metallurgy. George E. Walsh. Shows how the electric furnace has made possible the production of certain metals at a cost that would make them commercially profitable. 2000 w. Min & Sci Pr—July 1, 1905. No. 70680.

ELECTRO-PHYSICS.

Electrons.

Problems and Conclusions in the Electron Theory (Ergebuisse und Probleme der Elektronentheorie). H. A. Lorentz. A general review of the theory of electrons and the observations upon which it is based, together with some of the influences upon molecular physics. Two articles. 10,000 w. Elektrotech Zeitschr—June 15, 22, 1905. No. 70973 each B.

Insulation.

Compressed Gas as an Insulator. Report of a lecture by Harris J. Ryan. Gives results of testing the dielectric strength of gases under pressure. Ills. 2000 w. Elec Jour—July, 1905. No. 70809.

Magnetization.

Magnetizing by Continuous and by Alternating Currents (Ueber die Magnetisierung durch Gleichstrom und durch Wethselstrom). E. Gumlich and P. Rose. With diagrams showing the difference in magnetizing action of the two kinds of currents, and the respective current consumption. 6000 w. Elektrotech Zeitschr—June 1, 1905. No. 70966 B.

Magnets.

The Properties of Magnets Made of Hardened Cast Iron. B. O. Peirce. Abstract of a paper presented before the Am. Acad. of Arts & Sciences. Reports results of experiments made to determine whether such magnets might be used as a substitute for special steel magnets. 2000 w. Elec Rev, N. Y.—July 15, 1905. No. 70756.

Radio-Activity.

Apparatus for Measuring the Quantity and Penetration of X Rays (Appareils de Mesure des Facteurs Pénétration et Quantité de Rayons X). G. Contremoulins. Describing the metroradioscope and the radiophotometer, for quantitative work with X rays. 1500 w. Comptes Rendus—July 3, 1905. No. 70926 D.

Resistance.

The Variation of Electrical Resistance in the Contact of Carbon and Cast Iron. Eric Schoenau. Reports investigations of the variations of the resistance of such contacts. 500 w. Elec Wld & Engr—July 15, 1905. No. 70759.

Thermo-Elements.

The Relation Between Temperature and Voltage in Thermo-Elements (Zusammenhang von Temperatur und Spannung bei Thermoelemente). Arthur Palme. Diagrams giving results of measurements upon couples of various materials. 1000 w. Zeitschr f Elektrotechnik—July 2, 1905. No. 70990 D.

GENERATING STATIONS.

Baku, Russia.

Power Transmission in the Naphtha District of Baku. A. Gradenwitz. Illustrated description of the electric power station erected near the Caspian Sea to furnish power for boring the naphtha wells and pumping. 1000 w. Engr, U S A—July 1, 1905. No. 70588 C.

Clyde.

The Clyde Valley Electrical Power Company, Limited. Gives a diagram showing the area covered, and an illustrated description of the Yoker generating station. 3000 w. Elec Engr, Lond—June 23, 1905. No. 70630 A.

Commutation.

Commutating Magnets for Continuous Current Dynamos (Ueber Kommutierungsmagnete fur Gleichstrommaschinen). Robert Pohl. Describing the use of auxiliary poles to prevent the sparking of the commutator. 3000 w. Elektrotech Zeitschr—June 1, 1905. No. [illegible] B.

Costs.

Charges for Supply from Combined Lighting and Traction Stations. John Hall Rider. Read before the Munic. Elec. Assn. Analyzes the cost of producing electrical energy. Also short discussion. 2500 w. Elec Engr, Lond—July 7, 1905. No. 70788 A.

Notes on Costs and Tariffs for Electric Supply. Hamilton Kilgour. Read before the Incor. Munic. Elec. Assn. Shows a scientific basis for the determination of prices or discounts. Also discussion. 4800 w. Elect'n, Lond—June 30, 1905. No. 70711 A.

The Diversity Factor, and Its Influence on Motor Load Charges. A. M. Taylor. An investigation of the charges and how they are affected by diversity factor, motor load factor, etc. 2000 w. Elec Rev, Lond —June 23, 1905. No. 70633 A.

Dynamos.

Double-Field Dynamos for Single and Polyphase Currents (Doppelfeld Generatoren für Ein und Mehrphasenstrom). E. Ziehl. With diagrams of the windings, and a general discussion of the advantages of the improvement. 5000 w. Elektrotech Zeitschr—July 6, 1905. No. 70980 B.

The Leitner-Lucas Train-Lighting Dynamo. Illustrates and describes this system in its improved form, explaining its working and mechanical design. 2500 w. Elect'n, Lond—July 7, 1905. No. 70802 A.

The Lines of Force in Dynamos with Auxiliary Poles (Ueber Kraftlinien felder in Gleichstrommaschinen mit Wendepolen). S. Defris. An examination of the distribution of magnetism in continuous-current dynamos provided with auxiliary poles to prevent sparking. 2000 w. Zeitschr f Elektrotechnik—May 28, 1905. No. 70985 D.

Variable-Speed Dynamo. An illustrated account of the characteristics of this train-lighting dynamo, designed by Dr. E. Rosenberg, and its performance in actual service. Also editorial. 2500 w. Elec Wld & Engr—July 15, 1905. No. 70761.

Field.

The Electromagnetic Field in Dynamos (Das Elektromagnetische Feld in Maschinen). Fritz Emde. A mathematical study of the stationary magnetic field existing between the rotating and stationary members of a dynamo. Two articles, 6000 w. Zeitschr f Elektrotechnik—June 25, 1905. No. 70989 each D.

Hydro-Electric.

Modern Austrian Hydro-Electric Generating Plant. A. Steens. Illustrates and describes some interesting features of the central station in Zwolfmalgreien. A combination of an electric plant with water-works for the distribution of water for private use. 4000 w. Am Elect'n—July, 1905. No. 70603.

The Drammen Electricity Works (Elektrizitätswerk der Stadt Drammen). Fr. Thrue. A fully illustrated description of the hydraulic and electric features of the generating station at the Gravfos Falls, near Drammen, Norway. Two articles, 7000 w. Elektrotech Zeitschr—June 8, 15, 1905. No. 70969 each B.

The Sill Hydraulic Power Plant near Innsbruck. Franz Koester. Illustrated description of an interesting hydro-electric plant in the Tyrol. 1300 w. Eng Rec—July 1, 1905. No. 70601.

Isolated Plants.

The Economy of Isolated Plants. K. L. Aitken. Read before the Can. Elec. Assn. Deals with the smaller class of isolated plants which supplies light and power only to the building which contains the equipment. 3800 w. Can Elec News—July, 1905. No. 71040.

Load Factor.

Load Factor—Its Effect Upon an Electricity Station. Alex. Sinclair. Read before the Incor. Munic. Elec. Assn. An explanation of the effect of the load-factor upon the electricity supply works. Also discussion. 3300 w. Elect'n, Lond—June 30, 1905. No. 70709 A.

London.

The Supply of Electric Power to London. A Britton. A summary of the steps taken to unify the supply of current and electric power. 2500 w. Elec Wld & Engr July 8, 1905. No. 70692.

Marine Plants.

See Marine and Naval Engineering.

Municipal Station.

Proposed Municipal Electric Power Station for the City of New York. Drawings showing the general plan of the power plant, and discussing the general features; also reviewing the report of the Commission on Electric Lighting, submitted to the Mayor on June 19, 1905. 2500 w. Elec Rev, N Y—July 15, 1905. No. 70755.

The Supply of Electricity in Industrial Areas from a Municipal Point of View. William Hodgson. Read before the Incor. Munic. Elec. Assn. Discusses various phases of the problem. Brief general discussion. 2500 w. Elect'n, Lond—June 30, 1905. No. 70712 A.

Prepayments.

Electricity Supply by Free Wiring and Prepayment Meters. Alfred R. Sillar. Read before the Incor. Munic. Elec. Assn. Describes the author's method of introducing this system, the method of reading and collecting, etc. Short discussion. 3500 w. Elect'n, Lond—June 30, 1905. No. 70714 A.

Regulation.

On a Method of Potential Regulation Based on the Different Resistance Behavior of Carbon and Tantalum Lamps. A. E. Kennelly and S. E. Whiting. Shows how the difference in the temperature resistance characteristics may be employed for regulating the electromotive force of a generator. 1500 w. Elec Wld & Engr—July 1, 1905. No. 70596.

Sparking.

External Causes of Sparking in Direct-Current Machinery. Sydney Woodfield. Discusses in detail the more common causes of sparking. 3200 w. Elec Rev, Lond—June 30, 1905. No. 70718 A.

Station.

An Australian Station Having Compound-Wound Dynamos Paralleled with Accumulators. E. Kilburn Scott. Brief illustrated description of the station and its equipment. 1000 w. Elec Rev, Lond—June 30, 1905. No. 70717 A.

Synchronizer.

Automatic Synchronizing of Generators and Rotaries. Paul MacGahan. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Describes a device recently perfected by the Westinghouse Electric & Mfg. Co., describing the actions of the various parts. Ills. 1500 w. Engr, U S A—July 1, 1905. No. 70590 C.

See also Street and Electric Railways.

LIGHTING.

Arcs.

The Beck Lamp (Die Beck Lampe). Oskar Arendt. Describing an improved form of arc lamp with inclined carbons of the flame type. 1000 w. Elektrotech Zeitschr—June 8, 1905. No. 70971 B.

The Phenomena of the Singing Arc (Sur les Phénomènes de l'Arc Chantant). A. Blondel. An examination of oscillograph curves from various singing arcs. 1200 w. Comptes Rendus—June 26, 1905. No. 70923 D.

Illumination.

Standards for the Illuminating Power of Arc Lamps (Normen für die Lichtstärke von Bogenlampen). Dr. Norden. Suggesting the establishing of standards for photometric comparison, in connection with the work of the German electrical societies. 2500 w. Elektrotech Zeitschr—June 22, 1905. No. 70975 B.

The Action of the Spherical Photometer (Die Vorgänge im Kugelphotometer). R. Ulbricht. Describing a form of photometer for the direct determination of the mean spherical illuminating power of electric lamps. 4000 w. Elektrotech Zeitschr—June 1, 1905. No. 70968 B.

Incandescent.

Some Notes on the Incandescent Lamp. A. B. Lambe. Read before the Can. Elec. Assn. Outlines the method of measuring, tabulating and comparing the light from incandescent lamps, and discusses their mechanical features. Ills. 55[illegible] w. Can Elec News—July, 1905. No. 71039.

The Development of the Manufacture of the Edison Incandescent Electric Lamp—1881-1905. J. T. Marshall. A detailed account of the successive steps in the development of the Edison electric incandescent lamp from the period of its appearance to the present. Also discussion. Ills. 8500 w. Jour Fr Inst—July, 1905. No. 70842 D.

Mercury Lamp.

The Uviol Mercury Lamp (Die Uviol Quecksilberlampe). Dr. Axmann. Describing a mercury vapor lamp using a special glass permitting the passage of the ultra-violet rays, and especially adapted for medical purposes. 1200 w. Elektrotech Zeitschr—July 6, 1905. No. 70982 B.

Office Buildings.

The Lighting of Office Buildings. E. Leavenworth Elliott. Suggestions for adapting the illumination to the special needs. 1800 w. Cent Sta—July, 1905. No. 70690.

Street Lighting.

Street Lighting. E. E. Hoadley. Read before the Incor. Munic. Elec. Assn. Deals with the question from the point of view of a central-station engineer and the problems in towns of about 50,000 people. Shows that Nernst lamps can be used at less cost than incandescent gas lamps burning 4 cu. ft. of gas per hour. Also discussion. 6500 w. Elect'n, Lond—June 30, 1905. No. 70710 A.

Tantalum.

The Tantalum Lamp (Die Tantallampe). Otto Ely. A comparison of the performances of the carbon filament and the tantalum wire in incandescent electric lamps, with diagrams showing the current consumption and illuminating power. 1200 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 709[illegible] D.

MEASUREMENT.

Alternators.

The Testing of Alternators. Stanley P. Smith. Gives the results of a test made by the Behrend method, and the results of tests with unequal fields balanced, also results of a test with equal fields balanced, and gives conclusions as to the best methods. 1700 w. Elect'n, Lond—July 14, 1905. No. 708[illegible] A.

Cables.

Measurements of the Capacity of Long Submarine Cables (La Mesure de la Capacité des Longs Câbles Sous-Marins). M. Devaux Charbonnel. The method consists in charging the cable in cascade with a condenser of known capacity, from which the capacity of the cable may be deduced. [illegible] w. Comptes Rendus—June 13, 1905. No. [illegible] D.

Core-Loss.

A Method of Calculating the Core-Loss in Large Alternators. T. S. Allen. Explains a method of calculation which has been adopted by the Electrical Department of the Allis-Chalmers Co., and which gives very satisfactory results. 1400 w. Elec Wld & Engr—July 1, 1905. No. 70597.

Instruments.

The Computation of Revolving-Coil Measuring Appliances (Die Berechnung von Drehspul Messgeräten). F. Janus. Deriving formulas for the computation of the magnets, coils, and other portions of various measuring instruments. 3500 w. Elektrotech Zeitschr—June 15, 1905. No. 70974 B.

Iron Loss.

Notes on Iron Loss. F. Lydall. An account of experiments undertaken to ascertain how far the Steinmetz law held good with high densities. 1600 w. Elec Rev, Lond—June 23, 1905. Serial. 1st part. No. 70632 A.

The Measurement and Distribution of Iron Loss in Induction Motors (Messung und Trennung der Eisenverluste in den Asynchronen Drehstrommotoren). O. S. Bragstad. With diagrams to aid in the determination of hysteresis and eddy-current losses. 1800 w. Zeitschr f Elektrotechnik—June 18, 1905. No. 70988 D.

Losses.

The Distribution of Losses in Continuous-Current Dynamos (Zur Trennung der Verluste in Gleichstrommaschinen). W. Linke. With diagrams for practical use in dynamo testing. 1500 w. Elektrotech Zeitschr—June 29, 1905. No. 70979 B.

Magnetization.

Apparatus and Methods of Measurement of Coefficients of Magnetization (Appareil et Méthode de Mesure des Coefficients d'Aimantation). Georges Meslin. Describing the use of the torsion balance for determining magnetic coefficients. 1200 w. Comptes Rendus—June 26, 1905. No. 70924 D.

Meters.

Report of the Electric Testing Office (Bekanntmachung über Prüfung und Beglaubigungen durch die Elektrischen Prüfämter). A report of the electric testing department of the Reichsanstalt, authorizing the use of certain described electric meters in Germany. 6000 w. Elektrotech Zeitschr—June 29, 1905. No. 70977 B.

The Selection and Maintenance of Service Meters. William Bradshaw. On the mechanical construction, electrical characteristics, capacitv and maintenance of meters. Ills. 2500 w. Can Elec News—July, 1905. No. 71043.

Recorder.

Electric Spark Recorder. F. W. Springer. Illustrated description of an apparatus which has been in use six years and proven successful. 2000 w. Elec Wld & Engr—July 1, 1905. No. 70594.

Resistances.

The Measurement of Low Resistances. Lancelot W. Wild. Describes a little-known method of measuring low resistances that combines the sensibility of the differential galvanometer method with the highest degree of accuracy, it is claimed. 1000 w. Elect'n, Lond—July 14, 1905. No. 70887 A.

Voltameter.

An Iodine Titration Voltameter. D. Albert Kreider. Gives experimental investigations with a titration voltameter, showing the accuracy may be depended upon to about one part in ten thousand. 3000 w. Am Jour of Sci—July, 1905. No. 70811 D.

MOTORS.

Crane Motors.

Calculations for the Shaft, Gear and Bearings of Crane Motors. George J. Leire. Gives an example and illustrates the use of the table and diagrams given in the method of calculation. 900 w. Mach, N Y—July, 1905. No. 70585 C.

Diagram.

The Construction of the Current Diagram of a Polyphase Induction Motor (Konstruktion des Stromdiagrammes eines Mehrphasen Asynchronmotors). T. Rosskopf. Brief description, with geometrical proof. 600 w. Zeitschr f Elektrotechnik—June 11, 1905. No. 70987 D.

Induction Motors.

Auto-Starter for a 1,400-Horse-Power Induction Motor. Brief illustrated description of an apparatus manufactured by the Westinghouse Co. 900 w. Sci Am Sup—July 15, 1905. No. 70749.

Notes on the Induction Motor as Generator. T. P. E. Butt. Gives results of a test made by the writer, explaining the action of asynchronous generators. 3000 w. Jour S African Assn Engrs—May, 1905. No. 70626 F.

Notes on the Polyphase Induction Motor. H. A. Burson. Read before the Can. Elec. Assn. Considers the characteristics, the various types, and the classes of work to which each is suited. 1500 w. Can Elec News—July, 1905. No. 71041.

The Starting of Induction Motors. Frank Lewis. Illustrates and describes the selective winding designed by the writer, which does not require a complicated switchgear and which fulfils the conditions for efficient selection. 2000 w. Elec Rev, Lond—June 30, 1905. No. 70716 A.

Shunt Motors.

Shunt Motors for Electric Cranes. Claude W. Hill. Points out the advantages the shunt motor offers for driving the hoisting gears of cranes, more especially when the gears are remote from the controller. 700 w. Elec Rev, Lond—July 14, 1905. No. 70884 A.

Winding.

Notes on the Winding of Polyphase Rotors. Leonard J. Pumphrey. Deals with the design of windings for three-phase motors. 1200 w. Elec Rev, Lond—July 14, 1905. No. 70885 A.

TRANSMISSION.

Italy.

The Electric Transmission of Energy at 40,000 Volts between Gromo and Nembro (Transport d'Energies à 40,000 Volts entre Gromo et Nembro). L. J. Sidler. An illustrated description of the transmission portion of the Gromo hydro-electric plant, in northern Italy. 2500 w. 1 plate. Génie Civil—July 8, 1905. No. 70921 D.

Lightning Arresters.

Correct Position of Lightning Arresters in the Circuit and the Effect of Choking Coils. F. Neeson, in *Elektrotechnische Zeitschrift*. An account of some tests carried out at the Reichsanstalt for the purpose of determining whether a lightning arrester is most effective when connected as a shunt to the circuit, or when in series. The results point uniformly to the latter. 1200 w. Elec Engr, Lond—June 25, 1905. No. 70631 A.

Lines.

Regulation and Efficiency of Transmission Lines. Harold Pender. Calls attention to an error in the table found on page 126 of Foster's "Electrical Engineer's Pocket Book." 700 w. Elec Wld & Engr—July 1, 1905. No. 70595.

Long Distance.

A Long Distance Electric Power Transmission Line in Nevada. E. Prince. Brief description of a line to the Goldfield and Tonopah mining districts of Nevada and the interlying towns, now being constructed. 900 w. Eng News—July 6, 1905. No. 70616.

Niagara Power.

Transmission of Niagara Power to Toronto. The present article gives an illustrated description of the steel towers which are to carry four circuits for the transmission of 40,000 h. p. at 60,000 volts. 1500 w. Elec Wld & Engr—July 1, 1905. Serial. 1st part. No. 70503.

MISCELLANY.

Appliances.

Electric Appliances. A. Balsley. Gives experiences gained from the practical operation of electrical appliances, and apparatus, such as lamps, batteries, dynamos, rotaries and frequency changes. 2800 w. Pro S & S W Ry Club—April, 1905. No. 70815 C.

Brazil.

Electricity in Brazil. W. Whyte Gailey. Information concerning this country and the character of the electrical work. 2200 w. Elec Rev, Lond—June 23, 1905. No 70634 A.

Coast Defense.

Electricity in the Coast Defense. Illustrated description of the school at Fort Totten, N. Y., where officers of the artillery of the United States Army are taught how to use electricity in war. 1500 w. Elec Rev, N Y—July 29, 1905. No. 71105.

Lightning.

Modern Lighting Conductors. Killingworth Hedges. A discussion of the best method of protection, reviewing also the opinions of other writers. Ills. Also discussion. 3000 w. Jour Soc of Arts—May 26, 1905. No. 70825 A.

The Lightning Danger in Germany (Die Blitzgefahr in Deutschland). O. Steffens. A review of reports of lightning from various parts of Germany comparing these with the record of sunspots. 6000 w. Elektrotech Zeitschr—June 8, 1905. No. 70972 B.

Mexico.

Electric Power Developments in Mexico. Francis O. Blackwell. An illustrated article reviewing the progress in power developments. 4000 w. Cassier's Mag—July, 1905. No. 71025 B.

Portland Exposition.

Electrical Features of the Portland Exposition. An illustrated article describing the electrical service. 700 w. Elec Wld & Engr—July 22, 1905. No. 71047.

INDUSTRIAL ECONOMY

Coal Carrying.

A Great Coal Carrying Fleet. Remarks on the disappearance of the old steam collier fleet of the N. Atlantic coast, and the change to schooner-rigged barges, towed by large tugboats. 1500 w. Naut Gaz—July 13, 1905. No. [illegible]

Combinations.

Trade Selling Combinations (Les Comptoirs de Vente en [illegible]). A comparative study of the trade combinations known as Trusts in America, Cartells in Germany, and Comptoirs in France. 2000 w. Génie Civil—June 17, 1905. No. 70910 D.

Cost Keeping.

Cost Keeping in General Construction and Contract Work. A. W. Buel. The third and concluding paper discusses the elements of an improved cost-keeping system for an extensive contracting company. 3500 w. Engineering Magazine—August, 1905. No. 71059 B.

Depreciation.

The Depreciation Problem. John L. Bronson. Discusses briefly methods of getting an idea of the depreciation of a plant, and the problem of reconstruction. 1200 w. Cassier's Mag—July, 1905. No. 71026 B.

Education.

The Academic Side of Technical Training. Abstract of an address delivered before the University College, London, Union Society, by Dr. Alex. B. W. Kennedy. Review of engineering training, with suggestions. 4000 w. Elect'n, Lond—June 30, 1905. No. 70715 A.

The Navy Wireless School. Walter L. Beasley. An illustrated account of the wireless school established at the Brooklyn navy yard for training young sailors for this branch of service. 1000 w. Sci Am—July 15, 1905. No. 70745.

Export Trade.

Engineering Exports of Britain, Germany, and the United States. W. Pollard Digby. The third and concluding article discusses the trade of the West Indies and adjacent countries, British America, South Africa, and Australasia, in its relation to Great Britain. 3000 w. Engineering Magazine—August. 1905. No. 71056 B.

Labor.

The Labor Problem from an Engineer's Point of iew. William W. Bird. A lecture, considering the labor problem as a problem of forces, and discussing these forces in detail. 4500 w. Jour Worcester Poly Inst—July, 1905. No. 70806 C.

Laboratory.

The New Mechanical Laboratory of the Dresden Polytechnic (Les Nouveaux Laboratoire de Mécanique de l'Ecole Technique Supérieur de Dresde). With plans and elevations of the buildings, and a general account of the equipment. 2500 w. 1 plate. Génie Civil—July 1, 1905. No. 70920 D.

Mining Investments.

A Plea for Sane Mining Finance and More Conservative Mining Investments. Harry J. Newton. A discussion of the outlook in mining investment business. 3000 w. Min Wld—July 22, 1905. No. 71005.

New Ideas.

The Suggestion System. H. F. J. Porter. Explains a method whereby new ideas are encouraged, and their value estimated, and recommendation for adoption presented to the management of shops. Ills. 2000 w. Cassier's Mag—July, 1905. No. 71029 B.

Opportunities.

Opportunities for Engineering Graduates in the Government Service. John F. Hayford. Read before the Soc. for the Pro. of Engng. Ed. Deals with the opportunities for graduates in civil, mechanical, electrical and mining engineering. 2400 w. Eng News—July 13, 1905. No. 70740.

Wotks Management.

A Combined Bonus and Premium System. Hugo Diemer. Describing the practical introduction of the system in a stronghold of trades unionism. 3000 w. Engineering Magazine—August, 1905. No. 71060 B.

The Higher Law in the Industrial World. H. F. J. Porter. A consideration of the commercial and industrial value of altruistic principles as applied in manufacturing establishments. 4000 w. Engineering Magazine—August, 1905. No. 71054 B.

MARINE AND NAVAL ENGINEERING

Battleship.

The Japanese Battleship "Katori." Gives a description of this vessel, being built in England, and of its equipment. 1500 w. Engng—June 30, 1905. No. 70622 A.

Canoes.

Folding Canoes and Jointed Ores. Emile Guarini. Illustrates and describes a portable, collapsible boat exhibited at Brussels. 1000 w. Sci Am—July 8, 1905. No. 70621.

Coal Carrying.

See Industrial Economy.

Cruiser.

H. M. First-Class Cruiser Achilles. Illustration, brief description, and remarks concerning this recently launched vessel. 700 w. Engr, Lond—June 23, 1905. No. 70644 A.

The French Cruiser Leon Gambetta. Describes this first of three armored-cruisers for the French fleet. 700 w. Engr, Lond—July 7, 1905. No. 70794 A.

Destroyers.

The Destroyer "Huszar." Description of this destroyer built for the Austro-Hungarian Government, with comparison with destroyers built for the Japanese Government. Ills. 1100 w. Engng—June 23, 1905. No. 70639 A.

Dry Docks.

See Civil Engineering, Waterways and Harbors.

Electric Plants.

Electricity on Shipboard (Einiges über Schiffselektrotechnik). C. Schulthes. An examination of the electrical requirements on shipboard, with description of generators, wiring systems, etc., adapted for marine service. Serial. Part I. 3500 w. Glasers Annalen—July 1, 1905. No. 70931 D.

Explosion.

Steam-Pipe Explosion on Board the Steamship "Orizaba." Report of Board of Trade inquiry, by David G. Watson and Thomas Carlton. The explosion occurred on Nov. 25, 1904. Ills. 4500 w. Mech Engr—July 1, 1905. No. 70707 A.

Liners.

The Mammoth Cunard Liners. Describes interesting features of the two turbine-driven Cunarders now under construction, giving a cross-section. 1600 w. Sci Am—July 22, 1905. No. 70832.

Liquid Fuel.

Recent Developments in the Application of Liquid Fuel to Marine Boilers. A report of some highly successful tests carried out in England with various types of burners. Ills. 1500 w. Sci Am Sup—July 8, 1905. No. 70625.

Motor Boats.

Modern Motor Boats (Moderne Motorboote). Photographs and details of some recent motor boats of American and Swiss design. 1800 w. Schweiz Bauzeitung—May 27, 1905. No. 70952 B.

Motor Boats. Dr. William F. Durand. States the problems of this class of boats, especially considering the motive power plant, its design, character and installation. Ills. 3000 w. Marine Engng—July, 1905. Serial. 1st part. No. 70608 C.

Resistance.

Laws of Variation of Resistance of Ships. D. W. Taylor. Discusses the model basin experiments, and other calculations for obtaining an approximate method or formula of value in practice, representing the resistance of a vessel. 2800 w. Marine Engng—July, 1905. No. 70609 C.

Salvage.

The Salvage of the Dredger "Walter Bibby." An illustrated account of one of the most difficult salvage operations yet conducted. 1000 w. Engng—July 14, 1905. No. 70895 A.

Steamer.

The Fall River Line Steamer Providence. Illustrated detailed description of this new ship, the most luxuriously fitted of the Fall River Line. 1500 w. Marine Engng—July, 1905. No. 70607 C.

Steamship Machinery.

The Machinery of the Great Northern Steamship Dakota. Illustrated detailed description. 1100 w. Marine Engng—July, 1905. No. 70610 C.

Submarines.

The Loss of Submarine A 8. Extracts from the *Western Morning News* in the account of the trial of the survivors of this submarine which sank suddenly near Plymouth Sound on June 8. Also editorial. 7200 w. Engr, Lond—June 23, 1905. No. 70643 A.

Turbine Steamer.

The Turbine-Driven Isle of Man Steamer "Viking." An illustrated detailed description of an interesting vessel in which the Parsons steam-turbine takes the place of the reciprocating engine. 1500 w. Engng—June 30, 1905. No. 70725 A.

Vibrations.

The Schlick Pallograph. Dr. Alfred Gradenwitz. Illustrates and describes an apparatus for measuring and registering the vibrations of steamers. 1100 w. Sci Am Sup—July 15, 1905. No. 70748.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Air-Cooled Motors in Principle and Practice. Herbert L. Towle. Discusses the details of this class of motors, the advantages, requirements, devices used, &c. 1300 w. Automobile—July 20, 1905. Serial. 1st part. No. 70844.

Climax.

The 14 H. P. Climax Car. Illustration and brief description of the principal features and the working. 1400 w. Autocar—June 24, 1905. No. 70628 A.

Country Work.

Motor Cars for Country House Work. F. Strickland. A study of the requirements for such service. 2000 w. Autocar—July 15, 1905. No. 70877 A.

De Dietrich.

The 1905 De Dietrich Cars. Illustrates and describes the new models, of which there are four distinct types. 1600 w. Auto Jour—July 1, 1905. Serial. 1st part. No. 70706 A.

Light Car.

James and Browne Two-Cylinder Light Car. Illustrates and describes a motor car of British make, with combined engine crank chamber and gear box set below the floor level in the center of the frame. 1000 w. Autocar—July 1, 1905. No. 70704 A.

Motor Car.

Steam Motor Car for the Glasgow & Southwestern Ry. Illustrates and describes a motor car in which the engine is detachable from the car. 300 w. Eng News—July 20, 1905. No. 70825.

Motor Troubles.

What to Do When the Motor Balks. A. D. River. The first of a series of articles giving practical suggestions for tracing up troubles on the road and directions for applying the proper remedies. 1500 w. Automobile—July 13, 1905. Serial. 1st part. No. 70737.

Motor Vehicles.

Commercial Motor Vehicles. J. F. Gairns. The present article discusses steam motor vehicles adapted for the carriage of goods. Ills. 4800 w. Cassier's Mag—July, 1905. Serial. 1st part. No. 71027 B.

New Car.

The 18-24 B. A. C. S. Car. Illustrations and general details of a new car, built in France, for the British Automobile Commercial Syndicate. 900 w. Autocar—July 8, 1905. No. 70786 A.

Omnibuses.

English Motor Omnibuses for City and Country Use. Information concerning the motor omnibus traffic and its advantages, with illustrated descriptions of some of the vehicles in use in England. 4000 w. Sci Am Sup—July 29, 1905. Serial. 1st part. No. 71082.

Racing.

The Gordon-Bennett Cup in 1905 (La Coupe Gordon Bennett in 1905). F. Drouin. Describing especially the machines entering in the French preliminary trials. 2500 w. Génie Civil—July 1, 1905. No. 70919 D.

The Gordon-Bennett Race. Statistics of this race, with revised times of the competitors, the average speeds, &c. Ills. 2000 w. Auto Jour—July 15, 1905. No. 70874 A.

Rexette.

A Two-Cylinder Engined Rexette. Gives plan and elevation view of the chassis of a new machine, with description. 700 w. Autocar—July 15, 1905. No. 70876 A.

Runabout.

Construction and Operation of a Home-Made Steam Runabout. H. D. Penney. Illustrated description of a vehicle made by the writer, and its operation. 2800 w. Automobile—July 13, 1905. No. 70738.

Touring Car.

Pope-Tribune 12-H. P. Light Touring Car. Illustrated detailed description of the Pope-Tribune Model IV. 1200 w. Automobile—June 29, 1905. No. 70554.

The Tourist Trophy, and Its Value to Car Owners. Discusses the subject in a general way, showing how far the rules will secure the desired result, giving suggestions. 3800 w. Auto Jour—July 15, 1905. Serial. 1st part. No. 70875 A.

COMBUSTION MOTORS.

Gas Engines.

High Power Gas Engines in Electric Power Plants of German Ironworks. Frank C. Perkins. Brief illustrated descriptions of a 1,200-H.-P., double-acting, tandem gas engine, driving generator at the Dillingen iron-works, and a 650-H.-P. gas engine at the Holberger iron-works. 1200 w. Elec Rev, N Y—July 1, 1905. No. 70571.

Modern Gas and Oil Engine Practice. Horace Allen. States the necessary conditions of internal combustion motors, which have so successfully been fulfilled; reviews the history, and describes the practice followed in different types. Ills. 2500 w. Mech Engr—July 15, 1905. Serial. 1st part. No. 70879 A.

Some Modern Gas Engines. Illustrates and describes engines manufactured in Great Britain. 7500 w. Engr, Lond—June 23, 1905. Sup. No. 70645 A.

The Growth of Large Gas Engines on the Continent. Rodolphe E. Mathot. An illustrated review of the development, especially the improvements introduced during the past five or six years. 13500 w. Inst of Mech Engrs—June, 1905. No. 70646 D.

The Influence of Self-Acting and Controlled Admission Valves upon the Performance of Gas Engines (Der Einfluss Selbsttätiger und Gesteuerter Einlassventile auf Leistung und Verbrauch von Explosionsmotoren). K. Fehrmann. Discussing especially the influence of increased speeds upon the behaviour of uncontrolled valves. 2500 w. Zeitschr d

Ver Deutscher Ing—July 1, 1905. No. 70912 D.

The Mechanical Efficiency and Indicated Power of Gas Engines (Der Mechanische Wirkungsgrad und die Indizierte Leistung der Gas Maschine). Hugo Guldner. A discussion of the basis on which the mechanical efficiency should be computed, taking the compression resistance into consideration. 1500 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70908 D.

The Mees Gas Engine (Die Gasmaschine Bauart Mees). Fr. Freytag. Describing an improved gas engine in which the speed regulation is effected by a combination of the methods of varying the mixture and the volume of the charge. 3000 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70902 D.

Gas Power.

Electric Power from Blast Furnaces. P. Eyermann. Discusses the advantages of engines, driven by blast furnace gas, and the details of operation of such a plant. 2200 w. Ir Age—July 20, 1905. No. 70804.

Gas Producers.

European Gas Producers. Emile Guarini. Describes poor gas and its use for fuel; gas producers that work under pressure, and those which work by suction; and poor gas motors. Ills. 8000 w. Jour of Elec—July, 1905. No. 71038 C.

Internal Combustion.

Explosion Motors (Die Explosionsmaschine). L. Dölling. A general review of the development of the internal-combustion motor and its applications to power generating stations. Three articles. 7500 w. Zeitschr f Elektrotechnik—June 4, 11, 18, 1905. No. 70986 each D.

Internal Combustion Engines. Dugald Clerk. The first of a series of articles explaining the fundamental principles of these engines, and reviewing the history of their development. 5000 w. Jour Soc of Arts—July 7, 1905. Serial. 1st part. No. 70800 A.

Petrol Engines.

The White and Poppe Petrol Engines. Describes the accurate working methods in the manufacture of this engine, the extent of the interchangeable system, &c. Ills. 1700 w. Autocar—July 1, 1905. No. 70705 A.

HEATING AND COOLING.

Central Stations.

Notes on the Design of Central-Station Hot-Water-Heating Systems. J. D. Hoffman. Discusses the details of a typical design. 5000 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70824 C.

Combination Plant.

Baltimore Refrigerating and Heating Co.'s Plant. Illustrates and describes a combination power, heating, refrigerating and electric lighting service. 7800 w. Ice & Refrig—July, 1905. No. 70580 C.

District Heating.

District Heating. Gives some important data reported to the Nat. Elec. Lgt. Assn. in regard to heating in connection with electric lighting, and discusses the service generally. 2200 w. Eng Rec—July 15, 1905. No. 70784.

Drying.

Drying by Steam, Hot Air, and Waste Gases. Hugh J. Barron. A discussion of the best practice for drying various materials. 3300 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70823 C.

Dust.

Dust Deposition in Relation to the Heating of Buildings. W. F. Barrett. Extract from a paper recently read before the British Inst. of Heat. & Ven. Engrs. Discusses the cause of dust deposits on room walls. 1300 w. Met Work—July 22, 1905. Serial. 1st part. No. 70854.

Hot Air.

Possibilities in Heating with Hot Air. R. S. Thompson. Presents arguments in proof of the economy of this system of heating. 2500 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70822 C.

Hot Water.

Residence Heating by Direct and Indirect Hot Water. E. F. Capron. Describes a heating apparatus installed in a three-story and basement brick residence having exposure on all sides, with no protection from surrounding buildings. Ills. 500 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70819 C.

Radiation.

Sheet Metal Radiation. H. W. Nowell. Brief article, presenting the merits of sheet metal radiation. 700 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70820 C.

Refrigeration.

Test of an Absorption Refrigerating Machine (Untersuchung einer Absorptions-Kältemaschine). R. Habermann. With diagrammatic illustrations of the machine and complete tabulated data and results of test and heat balance. [illegible] w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70905 D.

Regulations.

German Heating and Ventilating Laws. Charles F. Hauss. Gives the German law covering all work in heating and ventilation. 3000 w. Met Work—July 1, 1905. Serial. 1st part. No. [illegible]

Rotary Furnace.

Heating a Church at Martin's Ferry, Ohio. An analysis of a rotary warm air furnace heating system. Ills. 2700 w. Met Work—July 22, 1905. No. 70853.

School Houses.

The Warming and Ventilation of School Houses (Ueber die Heizung und Lüftung von Schulhäusern). P. Hase. With graphical diagrams for computing the proportions of apparatus. 5000 w. Gesundheits-Ingenieur—June 20, 1905. No. 70995 B.

Steam Economy.

Some Observations on Steam Economy in Connection with the Heating Trade. O. M. Row. Read before the Inst. of Heat. & Ven. Engrs. Remarks on economy in the initial raising of the steam, and a discussion of the economical utilization. 6000 w. Plumb & Dec—July 1, 1905. No. 70727 A.

Steam Heating.

Steam Heating Principles. Prof. William J. Baldwin. A lecture before the Brooklyn Polytechnic Institute's College of Arts and Engineering. Discusses the history and practice of steam heating and defines the underlying principles. 2500 w. Dom Engng—July 1, 1905. Serial. 1st part. No. 70560.

Ventilation.

Experimental Researches upon the Flow of Air in Pipes (Versuche über den Widerstand bei Bewegung der Luft in Rohrleitungen). H. Rietschel. An exhaustive report of tests made at the Government shipyards at Kiel. 12000 w. Gesundheits-Ingenieur—July 1, 1905. No. 70998 B.

Flow of Air in Metal Pipes. J. H. Kinealy. Gives formula and table with information. 2000 w. Am Soc of Heat & Ven Engrs—July, 1905. No. 70821 C.

HYDRAULICS.

Centrifugal.

Centrifugal Pumps for High and Low Heads (Hoog en Laagdruk Centrifugaalpompen). Chr. Eeuwens. With sections and details of a number of recently designed pumps, including direct-driven multiple-stage pumps for high-pressure service. 4000 w. 2 plates. De Ingenieur —June 17, 1905. No. 71051 D.

Pumping Engine.

72,000,000-Gallon Pumping Engine at Boston, Mass. Illustrated detailed description of a pumping engine believed to be the largest reciprocating pump in the world, recently installed for the Boston Main Drainage Works, of the Sewer Division. 2000 w. Eng News—July 6, 1905. No. 70614.

Pumps.

Modern Duplex, Flywheel and Turbine Pumps (Neuere Duplex-Pumpmaschinen, Schwungrad-Pumpmaschinen, und Turbinenpumpen). Otto H. Mueller. A critical comparison of modern large pumping machines of the several types, with details of construction and data of performances. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70900 D.

Westinghouse Compound Pump. F. H. Parke. Illustrated description of the design and operation. 1600 w. R R Gaz—Vol. XXXVIII., No. 26. No. 70559.

See Civil Engineering, Water Supply.

Pump Tests.

Test of a High-Speed Rotary Pump (Versuche mit Einer Schnellaufenden Kapselpumpe). O. Kammerer. The pump was of the rotary piston type, directly driven by an electric motor, and the results of the test are given in graphic and tabular forms. 2000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70907 D.

Valves.

The Gutermuth Patent Valve. Illustrated description of a simple and novel valve for pumps, compressors, blowing engines, &c. 1200 w. Ir Age—July 6, 1905. No. 70561.

Valves (Ventile). H. Raschen. A discussion of the unequal wear upon lift and check valves, due to the oblique flow of the fluid, with suggestions to obviate this action. 2000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70906 D.

Water Power.

Formulas and Computations for Horse-Power Value of Streams. W. L. Church. The object of the paper is to derive formulas for the rapid estimate of the discharge value of a given drainage area, and to illustrate and simplify the method of computation of the value of a drainage area in connection with partial storage and steam auxiliary. 3000 w. Eng Rec —July 1, 1905. No. 70600.

The Hydraulic Power Plant on the Sill near Innsbruck (Die Wasserkraftmaschinen der Sillwerke bei Innsbruck). Andreas Stamm. An illustrated description of the hydraulic portion of the hydro-electric station supplying the city of Innsbruck. Pelton wheels are used. 2500 w. Zeitschr d Ver Deutscher Ing—June 17, 1905. No. 70901 D.

The Industrial Economy of Water Power (L'Economie Industrielle des Forces Hydrauliques). E. F. Cote. An exhaustive discussion of the economics of water power, with especial reference to controlling legislation in France. 10000 w. Mem Soc Ing Civ de France—May, 1905. No. 70932 G.

MACHINE WORKS AND FOUNDRIES.

Annealing Furnaces.

Coal-Dust Firing as Applied to Annealing Furnaces. Illustrates and describes annealing furnaces fitted with the Schwartzkopff system of coal-dust firing, and states results. 1000 w. Ir & Coal Trds Rev—June 23, 1905. No. 70647 A.

Automatic Machinery.

Compressed Air Marking Machine. H. J. White. Drawings and description, explaining operation. 900 w. Am Mach—Vol. 28, No. 29. No. 70817.

Casehardening.

Casehardening. David Flather. Read before the Cycle Engrs.' Inst., Birmingham, Eng. States the advantages sought in this process, and reviews the methods. 7500 w. Mech Engr—June 24, 1905. No. 70629 A.

Castings.

Cored Work in Aluminium Casting. Walter J. May. Suggestions for the casting of aluminium and its alloys. Ills. 900 w. Prac Engr—July 14, 1905. No. 70878 A.

The Production of Homogeneous Steel Castings Free from Internal Stresses (Ueber die Mittel zur Erzielung Dichter und Spannungsfreier Stahlformgussstücke). L. Treuheit. Discussing methods of moulding and pouring steel castings so as to avoid the production of blowholes and cooling stresses. Serial. Part I. 1800 w. Stahl u Eisen—June 15, 1905. No. 70941 D.

Chains.

Chain-Making by Electric Welding. Andris-Jochams. Illustrated description of the method of making chain by the Giraud process, stating the advantages of electric welding, and giving information regarding cost and quality. 3000 w. Ir Age—July 13, 1905. No. 70731.

Cranes.

10-Ton Electric Overhead Traveller at the Liége Exhibition. Illustrated detailed description, showing the use of three-phase current by placing a motor-generator on the crane. 800 w. Engng—July 14, 1905. No. 70896 A.

Cutting Speeds.

Cutting Speeds for Shapers and Slotting Machines. Frank B. Kleinhans. The first of an article in three parts. Explains the four ways of obtaining the quick return motion for shapers and slotting machines, investigating, in the present number, the cutting speed of the tool on a slotting machine. 1200 w. Mod Mach—July, 1905. Serial. 1st part. No. 70563.

Electric Driving.

Individual vs. Belt Drive in Electrically Operated Shops. Putnam A. Bates. An illustrated article discussing some mistakes made in installing electric apparatus, and the advantages of the individual motor drive. 1800 w. Am Elect'n—July, 1905. No. 70604.

Recent Machine Tools with Electric Driving (Neuere Werkzeugmaschinen mit Elektrischem Antrieb). Paul Moller. Illustrations of lathes, shapers, and drill presses arranged for direct electric driving; designed by the Oerlikon Works. 2500 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70904 D.

Estimates.

Estimating the Cost of Machine Work. J. A. Webster. Gives an analysis of the various operations to be performed in a machine taken as an example. Ills. 3500 w. Mach, N Y—July, 1905. No. 70586 C.

Factory.

The New Belting Factory of Charles A. Schieren & Company. Describes the details in the manufacture of belts, and gives an illustrated description of this New York factory. 1200 w. Am Mach—Vol. 28, No. 29. No. 70816.

Forming.

Improved Methods of Forming Hollow Vessels of Sheet Metal (Neuerung in der Ausbrauchung von Blechhohlkörpern). Karl Musiol. Illustrating workshop methods of rolling and forming sheet metal in the lathe, with the aid of moulds and patterns. 2000 w. Stahl u Eisen—July 1, 1905. No. [illegible] D.

Foundry.

A Combined Baby Bessemer and Open Hearth Steel Foundry. Prof. Hermann Wedding. From a paper in *Verhandlungen des V. zur Beforderung des Gewerbfleisses.* Explains the three lines along which the baby Bessemer process may be developed, and the details of operation, and gives illustrated description of the new plant of Otto Gruson, near Magdeburg. 2800 w. Ir Age—July 27, 1905. No. 71032.

Electricity in a Malleable Iron Foundry. H. P. Kernochan. Describes the electric equipment of the foundry of the Troy Malleable Iron Co., Watervliet, N. Y., for power and lighting. 1100 w. Elec Rev, N Y—July 8, 1905. No. [illegible]

Guns.

How Gun-Barrels Are Straightened. William H. Avis. An explanation of the method of straightening, with illustrations. 1400 w. Am Mach—Vol. 28, No. 28. No. [illegible]

Hopper.

Laying Out a Hopper for a Coal Chute by the Method of Triangulation. George Guntz. Drawings and description of the method used. 1000 w. Boiler Maker—July, 1905. No. [illegible]

Milling.

Semi-Automatic Hinge-Milling Machine. Francis W. Shaw. Illustrated detailed description of the machine and its operation. 1300 w. Am Mach—Vol. 28, No. 28. No. 70735.

Molding.

Making a Molder. H. M. Lane. Read before the Am. Found. Assn. Discusses present conditions and the training needed to make good molders. 2400 w. Foundry—July, 1905. No. 70861.

New Works.

Park Works, Huddersfield. Illustrated description of new gear-cutting works and their equipment. 2000 w. Engr, Lond—July 14, 1905. No. 70892 A.

Pipe Threads.

British Pipe Threads. W. H. Booth. An explanation of past and present practice in Great Britain. 2000 w. Am Mach—Vol. 28, No. 30. No. 71071.

Power Plant.

Power Plant at the Factory of Edward R. Ladew. Paul H. Grimm. Illustrated detailed description of the plant in the new factory at Glen Cove, N. Y., with report of one of the tests made periodically. 2400 w. Power—Aug., 1905. No. 71035 C.

Projectiles.

Coast Artillery Projectiles. Describes the function of armor-piercing projectiles, their design, manufacture, &c. 4800 w. Jour U S Art—May, 1905. No. 71031 D.

Soldering.

On Autogenous Lead Soldering. M. U. Schoop. Remarks on the methods of welding without any flux or any foreign metal that are of special value for storage battery factories. Especially considers the oxygen-hydrogen flame and its advantages. 1100 w. Elec-Chem & Met Ind—July, 1905. No. 70669 C.

Tool Room.

The Tool Room and Stock Room. Oscar E. Perrigo. Describes and illustrates the complete arrangements from the time stock is wanted until it is accounted for: the design, arrangement, and accounting systems. 5000 w. Ir Trd Rev—July 6, 1905. No. 70617.

Tools.

Some Corliss Engine Tools. Illustrates and describes some special appliances in use in the shops of the Hardie-Tynes Works, Birmingham, Ala. 1200 w. Am Mach—Vol. 28, No. 28. No. 70733.

Tool Shops.

Tool Shops of the Kawasaki Dockyard Company. Gompei Kuwada. An illustrated explanation of the outfit of machine tools and how they are arranged. 900 w. Am Mach—Vol. 28, No. 30. No. 71072.

Tool Steels.

High-Speed Tool Steels (Les Aciers à Outils à Coupe Rapide). J. Garnier. A description of the shop methods of preparing and using high-speed steels, with some data as to results. 2500 w. Génie Civil—June 17, 1905. No. 70914 D.

Waste.

Utilizing Unconsidered Trifles. From *English Mechanic and World of Science.* Directs attention to ways in which worn-out files, iron-gas-piping, old rails, and various other things may be utilized. 1200 w. Sci Am Sup—July 8, 1905. No. 70624.

Welding.

The Thermit Process in American Practice. Ernest Stutz. Read at the meeting of the Am. Soc. for Test. Materials. Some applications and the methods are explained. 2300 w. Ry & Engng Rev—July 22, 1905. No. 71008.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Abrasives.

The Industry of Abrasives and Corundum (L'Industrie des Abrasifs et le Corindon). A. de Romeu. A general review of the use of abrasive material in mechanical operations, with especial reference to the exploitation of deposits of corundum. 6000 w. Rev Gen d Sciences—June 15, 1905. No. 70993 D.

Alloys.

Alloys of Copper (Les Alliages de Cuivre). Leon Guillet. A general study of the present state of knowledge of ordinary and special bronzes and brasses. Serial. Part I. 3000 w. Génie Civil—June 24, 1905. No. 70918 D.

Brass.

The Dead, or Matt Dip for Brass. From the *Brass World.* The dead dip is the dip used to impart a satiny finish to brass. The method of producing this finish is described. 1200 w. Am Mach—Vol. 28, No. 29. No. 70818.

Cast Iron.

Hard Cast Iron. Henry Souther. Read before the Am. Soc. for Test. Materials. A brief account of trouble with very hard iron and the remedy. 800 w. Ir Tr Rev—July 13, 1905. No. 70736.

Methods for Testing Cast Iron. Richard Moldenke. Read before the Atlantic City meeting of the Am. Soc. for Test. Materials. Reviews the American and English pig iron specifications, and the method by which the metal is judged. 2400 w. Ir Age—July 13, 1905. No. 70732.

Galvanizing.

Comparative Tests of Iron and Steel Articles Galvanized by the Hot and Cold Processes (Vergleichsversuche mit Eisen und Stahlwaren auf Heissem und Elektrolytischem Wege Verzinkt). Dr. Ignaz Szirmay. Results of tests upon sheet metal, wires, and pipe, showing the superiority of the electrical process. 1500 w. Zeitschr f Elektrochemie—June 2, 1905. No. 70992 D.

Heat Insulation.

Notes on Heat Insulation, Particularly with Regard to Materials Used in Furnace Construction. R. S. Hutton and J. R. Beard. A record of experimental investigations and results. Ills. 1500 w. Elec Rev, N Y—July 22, 1905. No. 71011.

Laboratory.

See Industrial Economy.

Steels.

Constitution and Properties of Aluminum Steels (Constitution et Propriétés des Aciers à l'Aluminium). Léon Guillet. A brief review of micrographic and mechanical examinations of steels containing up to 15 per cent. of aluminum. 1000 w. Comptes Rendus—July 3, 1905. No. 70927 D.

Constitution and Properties of Steels Containing Tin, Titanium, and Cobalt (Constitution et Propriétés des Aciers à l'Etain, des Aciers au Titane, et des Aciers au Cobalt). Léon Guillet. A brief note giving the mechanical properties of these alloy steels; at present of no practical value. 800 w. Comptes Rendus—June 26, 1905. No. 70952 D.

Special Steels. L. Guillet. Describes investigations made of certain ternary alloys and steels, particularly two grades, one containing only about 2% of carbon, and the other approximating to the eutectic and containing about 8% of carbon. 2300 w. Ir & Coal Trds Rev—June 30, 1905. No. 70729 A.

Testing.

The Testing Laboratory of the Conservatoire des Arts et Métiers (Organisation et Outillage du Laboratoire d'Essais du Conservatoire des Arts et Métiers). A. Perot. A general account of the new testing laboratory, and its relation to public and private industries. 4000 w. Mem Soc Ing Civ de France—May, 1905. No. 70935 G.

MEASUREMENT.

Friction.

The Friction of Ropes and Chains over Sheaves (Ueber Reibung von Seilen und Ketten auf den Triebscheiben). H. Herrmann. Deducing formulas for the computation of the sheave friction of winding cables, with especial reference to the Koepe system of mine hoists. 1000 w. Glückauf—June 30, 1905. No. 70948 D.

Harmonic Analysis.

The Harmonic Analysis of Valve Motions. Silvanus P. Thompson. An explanation of a very simple method. 800 w. Engng—July 14, 1905. No. 70894 A.

Temperature.

Thermometers and Pyrometers, with Some of Their Industrial Applications. Abstract of a lecture by Robert Whipple, delivered before the Cleveland Inst. of Engrs., England, describing these instruments and the uses to which they are applied. Ills. 4000 w. Sci Am Sup—July 22, 1905. No. 70840.

Torsion Meter.

Torsion Meter for Recording the Horse Power of Steam Turbines. Illustrates and describes the apparatus invented by Archibald Denny and Charles Henry Johnson. 2000 w. Sci Am Sup—July 29, 1905. No. 71084.

POWER AND TRANSMISSION.

Compressed Air.

A High Speed Electrically Driven Compressor for Colliery Work. W. Reavell. Read before the S. Wales Inst. of Engrs. Illustrated description of a machine which can be directly driven by an electric motor and can be made in small units when desired. 3800 words. Ir & Coal Trds Rev—July 14, 1905. No. 71001 A.

Flow of Air in Pipes and the Transmission of Power by Compressed Air. Gives some theoretical considerations and calculations. 1200 w. Mines & Min—July, 1905. No. 70688 C.

Study of a Riedler Air Compressor. Arthur P. Hall. Explains the general working of the machine, and gives a series of cards taken under various conditions. 600 w. Compressed Air—July, 1905. No. 70796.

Suggestions for Running Air Compressors. M. W. Sherwood. Suggestions for setting and leveling, measuring and adjusting clearance, lubrication, etc. 12,000 w. Mines & Min—July, 1905. No. 70686 C.

Temperatures in Air and Ammonia Compressor Cylinders. Leicester Allen. A discussion of the indeterminate character of present information about compression temperatures. 3000 w. Engineering Magazine—August, 1905. No. 71057 B.

Conveying.

Coal Conveying Plant at the Metropolitan Electric Supply Co.'s Works. Illustrates and describes the methods of coal handling and firing employed at the Willesden Junction plant. 1500 w. Engng—July 14, 1905. No. 70898 A.

Power Plants.

Details of the Wanamaker Power

House, Philadelphia. Illustrated detailed description of arrangements for furnishing steam heat, electric light, pneumatic service, ventilation and refrigeration for one of the largest stores ever built. 2500 w. Eng Rec—July 22, 1905. Serial. 1st part. No. 71020.

Modern Power-Plant Design and Economics. Franz Koester. The first article discusses location, design of buildings, and general adaptability; comparing American and European practice. 3500 w. Engineer-the Magazine—August, 1905. No. 71058 B.

New Mechanical Plant of the Connecticut Hospital for the Insane. Illustrated detailed description of recent important changes in the mechanical plant, especially the new boiler-house, systems of piping, etc. 2200 w. Eng Rec—July 8, 1905. No. 70698.

The Gas Power and Heating Plant of the Atha Tool Co. J. R. Bibbins. Illustrated detailed description of a recently completed plant in Newark, N. J. 1800 w. Eng Rec—July 15, 1905. No. 70779.

Prime Movers.

The Choice of Prime Movers for Town Premises. W. H. Y. Webber. Discusses briefly the case of the power user in any town which is not given wholly to manufacturers. 2200 w. Gas Wld—July 15, 1905. No. 70870 A.

STEAM ENGINEERING.

Boilers.

Steam Boilers and Pipes. The first of a series of articles on essential points which must come before architects who are required to make provision for steam-producing plants in hospitals, asylums, schools, hotels, and other buildings. 2400 w. Builder—July 1, 1905. Serial. 1st part. No. 70701 A.

Boiler Scale.

The Use of Boiler Compounds. William M. Booth. From *The Chemical Engineer.* Considers the materials used, their effects, cost, and related matters. 1000 w. Eng News—July 27, 1905. No. 71069.

Chimneys.

The Design of Self-Supporting Steel Chimneys. John D. Adams. Considers the thickness of plates, the foundation, anchor-bolts, and tapering stocks. 2500 w. Eng News—July 20, 1905. No. 70827.

Discharge.

The Discharge of Hot Water from Tanks (Das Ausströmen Heissen Wassers aus Gefässmündungen). Dr. A. Fliegner. Deriving formulas for the flow of hot water, analagous to those for saturated steam. Two articles, 3000 w. Schweiz Bauzeitung—June 10, 24, 1905. No. 70954 each B.

Economy.

Suggestions for Steam Economy. Wm. McKay. Read before the Can. Elec. Assn. A discussion of some of the principles upon which economy in the use of steam depends. 2800 w. Can Elec News—June, 1905. No. 71042.

Engines.

Choosing an Engine for an Isolated Plant. H. S. Knowlton. Discusses points to be considered in the selection of engines for certain work 2700 w. Cassier's Mag—July, 1905. No. 71028 B.

Double-Piston Francois Engines. Gives particulars in regard to these engines, illustrated in a previous issue, and some results obtained with them. 2000 w. Engng—July 14, 1905. No. 70899 A.

Modern Economical Steam Engines and Turbines. Gives results obtained with some of the most modern engines and turbines. Ills. 1500 w. Engr, Lond—July 7, 1905. Serial. 1st part. No. 70791 A.

Robb-Armstrong Corliss Engines. Illustrates and describes the interesting features of these engines for slow and medium speeds. 1500 w. Can Engr—July, 1903. No. 70649.

750-Horse-Power Sulzer-Carels Engine. Illustrates and describes this horizontal compound condensing engine, shown at the Liége Exhibition. 1000 w. Engr, Lond—June 30, 1905. No. 70728 A.

16,000-Horse-Power Vertical Rolling-Mill Engines. Fully illustrated description of quite a departure in rolling-mill engines, believed to be the most powerful engine yet built for this purpose. 1600 w. Engng—June 23, 1905. No. 70637 A.

The Van den Kerchove Piston-Valve Engine. Illustrated description of a horizontal compound tandem steam engine with piston-valves, exhibited at the Liége Exhibition. 1500 w. Engng—June 30, 1905. No. 70724 A.

300 H.-P. Double-Piston (Francois Type) Compound Condensing Engine. Illustrations of an engine built by the Cockerill Company, and exhibited at Liége. 200 w. Engng—July 7, 1905. No. 70790 A.

Triple-Expansion Engine for Melbourne Corporation. Brief illustrated description. 1200 w. Elec Engr, Lond—June 30, 1905. No. 70719 A.

Explosion.

See Marine and Naval Engineering.

Feed-Water.

Some Phases of the Feed-Water Heater Problem. Walter E. Harrington. Urging the use of open feed-water heaters and presenting their advantages. 2800 w. St Ry Jour—July 22, 1905. No. 71013 C.

Flue-Gas.

Flue-Gas Analysis. F. H. Corson. Illustrates and describes apparatus for the analysis of the products of combustion, and its action. 1800 w. Elec Rev, Lond—July 14, 1905. No. 70883 A.

Fuel Tests.

Steam and Producer-Gas Tests of Coal. From the report on the tests of fuel made at St. Louis, by the U. S. Geol. Survey, giving table showing the comparative results of burning the various coals under the boiler and in the gas producer, and discussing the results. 1000 w. Eng & Min Jour—July 6, 1905. No. 70672.

Liquid Fuel.

See Marine and Naval Engineering.

Portable Engines.

Modern Portable Engines (Moderne Lokomobilen). Describing especially the portable and semi-portable engines of Wolf, of Magdeburg, which have given excellent economical performances. Three articles. 7500 w. Oesterr Wochenschr f d Oeffent Baudienst—May 27, June 3, 10, 1905. No. 70959 each D.

Steam Heating.

See Mechanical Engineering, Heating and Cooling.

Steam-Jacketing.

An Investigation to Determine the Effects of Steam-Jacketing upon the Efficiency of a Horizontal Compound Steam Engine. A. L. Mellanby. Read before the Inst. of Mech. Engrs. A report of experimental investigations and results. 1800 w. Engr, Lond—June 30, 1905. Serial. 1st part. No. 70880 A.

Superheating.

The Application of Superheated Steam to Piston Engines (Die Anwendung des Ueberhitzen Dampfes bei der Kolbenmaschine). Otto Berner. A study of various tests of engines using super-heated steam, forming the introduction to a general investigation of the subject. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—July 1, 1905. No. 70910 D.

Traps.

Modern Steam Traps. W. T. Edwards. Brief illustrated descriptions of modern types of steam traps, their methods of operation, and in some cases the manner of piping recommended to obtain the best results. 3500 w. Am Elect'n—July, 1905. No. 70606.

Turbines.

Efficiency Tests of a 400-Kilowatt Steam Turbine. Report of an acceptance test made at Providence, R. I., the method of testing following as closely as possible the standard of the A. S. M. E. 1000 w. Power—August, 1905. No. 71034 C.

Operating Features of the Vertical Curtis Steam Turbines. August H. Kruesi. Read before the Nat. Elec. Lgt. Assn. Discusses balance, bearings and lubrication, valves and governor, clearance, low and high pressure turbines, etc. Ills. 4000 w. Eng Rec—July 1, 1905. No. 70599.

The Parsons Steam Turbine on German Warships. Dr. Alfred Gradenwitz. Illustrates and describes particulars of the special arrangement chosen for two turbine-driven vessels. 1000 w. Sci Am Sup—July 8, 1905. No. 70622.

The Sulzer Steam Turbine (Dampf-Turbine von Gebrüder Sulzer). .Description, with sectional view, of the new steam turbine designed by Sulzer Brothers, of Winterthur, Switzerland. 1800 w. Schweiz Bauzeitung—July 1, 1905. No. 70957 B.

Steam Turbines (Dampfturbinen). A. Wenger. Describing especially the steam turbines made by the Union Company, of Essen, with tabulated results of tests on a 50-horse-power turbine. 2000 w. Zeitschr d Ver Deutscher Ing—June 24, 1905. No. 70909 D.

Valve Gear.

A New Corliss Valve Gear. F. Hardie Jeannin. Illustrates and describes a valve gear which relates to the class of steam engines using rotary exhaust valves, and rotary induction valves tripped by a suitable device and closed by means of a dashpot. 1500 w. Engr, U S A—July 1, 1905. No. 70589 C.

A Study of the Walschaert Valve-Motion. W. Pfitzner. Translated from the *Zeitschrift des Vereins Deutscher Ingenieure*. The object of the study was to enable a valve motion to be designed on paper to a convenient scale and with sufficient certainty to render it unnecessary to test the design on a model. Ills. 2400 w. R R Gaz—Vol. XXXIX. No. 4. No. 71075.

Valve Leakage.

Steam Jackets and Valve Leakage. Prof. R. H. Smith. Reviews the report of the Steam Engine Research Committee of the Institution of Mechanical Engineers. 2700 w. Engr, Lond—June 23, 1905. No. 70641 A.

Waste Heat.

Method of Using Waste Heat. Howard N. Eavenson. Describes and illustrates the method of using waste heat from coke ovens for firing boilers at the No. 1 works of the Continental Coke Co. 1500 w. Mines & Min—July, 1905. No. 70683 C.

Water Gage.

Water Gage Glasses. J. Russell Mackay. Suggestions, based on long experience, for the renewal of water-gage glasses. Ills. 1200 w. Power—Aug., 1905. No. 71036 C.

MISCELLANY.

Aeronautics.

A New Aeroplane. Israel Ludlow. Illustrated description of the writer's design. 1500 w. Sci Am—July 15, 1905. No. 70746.

The Lebaudy Dirigible Balloon (Le Dirigeable Lebaudy). H. Julliot. A very complete account of the experiments made by Lebaudy with dirigible balloons since 1896, with detailed description of the 1904 model. 12,000 w. Mem Soc Ing Civ de France—May, 1905. No. 70936 G.

Air.

Atmospheric Friction as an Obstacle in Locomotion. Dr. A. F. Zahn. An illustrated description of experiments made to determine laws governing air resistance in moving bodies. 1500 w. Sci Am—July 22, 1905. No. 70835.

Low Temperatures.

Lord Blythswood's Liquid Air Plant for Experimental Work at Low Temperatures. Illustrates and describes apparatus for liquefying air and hydrogen gas. 1800 w. Sci Am Sup—July 2, 1905. No. 70836.

Telescope.

The Construction of a Silvered Glass Telescope, Fifteen and a Half Inches in Aperture, and Its Use in Celestial Photography. Henry Draper. Historical sketch, with illustrations. 6000 w. Sci Am Sup—July 29, 1905. Serial. 1st part. No. 71086.

MINING AND METALLURGY

COAL AND COKE.

Alaska.

The Outlook for Coal-Mining in Alaska. Alfred H. Brooks. Information in regard to fuel-consumption in Alaska, the known coal-bearing rocks, the composition and fuel value of the coals, the coal-fields, etc. 6000 w. Map. Am Inst of Min Engrs—July, 1905. No. 71094 C.

Coal Carrying.

See Industrial Economy.

Coke.

By-Product Coke. Edwin A. Moore. Describes the method of manufacturing coke and the recovery of the by-products from the coal by means of the Otto-Hoffman system. Describes the plant of the Camden Coke Co., Camden, N. J. Ills. 8500 w. Mines & Min—July, 1905. No. 70687 C.

Coke Drawing.

A Machine for Drawing Coke from Bee-Hive Ovens. George T. Wickes. Illustrates and describes a machine put in operation in Uniontown, Pa., and reported to have met successfully all the tests to which it has been subjected. States its advantages. 2000 w. Am Inst of Min Engrs—July, 1905. No. 71100.

Colliery Practice.

The Price-Pancoast Colliery. George W. Harris. A description of this colliery, especially the surface arrangements and methods of preparing the coal for market in practice in the Lackawanna region. Ills. 2400 w. Eng & Min Jour—July 15, 1905. Serial. 1st part. No. 70752.

Disaster.

The United National Colliery Disaster. An illustrated article giving facts in regard to the explosion which occurred on July 11, and describing the equipment of the mine. 1800 w. Ir & Coal Trds Rev—July 14, 1905. No. 71002 A.

South Wales.

Geology of the South Wales Coal-Field. Information from the recently published Geological Survey Memoir. 5200 w. Engng—June 23, 1905. No. 70636 A.

COPPER.

Concentration.

Concentrating Methods at the Arizona Copper Company, Clifton, Arizona. A. Morrison. An illustrated article describing the methods. 900 w. Min Rept—July 6, 1905. No. 70679.

Deposits.

The Copper-Deposits of San Jose, Tamaulipas, Mexico. J. F. Kemp. Gives the situation and geology, describing the eruptive rocks which present rare types, and considering the methods whereby they could have been produced. 8000 w. Am Inst of Min Engrs—July, 1905. No. 71101 C.

Kedabeg Mines.

The Kedabeg Copper Mines. Gustav Köller. Gives location, history and description of these mines, the methods of working, treatment, etc. Ills. 13700 w. Inst of Min & Met—April 13, 1905. No. 70852 D.

Mines.

Foreign Copper Mines. Walter Harvey

Weed. A review of the world's supply of copper, showing that for many years to come the bulk must be derived from the United States and Mexico. Ills. 5500 w. Min Mag—July, 1905. No. 70856 C.

Prospects.

Copper Prospects. T. Lane Carter. Suggestions for prospecting for copper, the outfit needed, methods of determination, etc. 3500 w. Jour Chem, Met & Min Soc of S Africa—May, 1905. No. 70873 E.

Queensland.

Copper in Southern Queensland. Gives information concerning these deposits, describing the geology. 2300 w. Aust Min Stand—June 7, 1907. No. 70703 B.

Mount Molloy Copper Mine, North Queensland. An illustrated description of the mine and smelters. 2000 w. Queens Gov Min Jour—May 15, 1905. No. 70627 B.

Slag.

A Slag Calculation. Charles S. Palmer. Gives a method for the calculation of copper blast-furnace slag. 1000 w. Eng & Min Jour—June 29, 1905. No. 70581.

Utah.

The Cactus Copper Mine, Utah. S. F. Emmons. A brief description, giving the location, history, development, geology, etc. 2400 w. Ores & Metals—July 1, 1905. No. 70592.

GOLD AND SILVER.

Australia.

Mining in Western Australia. W. H. Burrell. Brief report of the condition of the mines of gold, silver and copper, the past production, and the future outlook. 1500 w. Mines & Min—July, 1905. No. 70685 C.

The Australian Northern Territory. John Plummer. Gives testimony of various explorers concerning valuable deposits of gold, silver, tin and other metals in this region. Ills. 1400 w. Min Wld—July 8, 1905. No. 70661.

Banket.

The Genesis of the Tarkwa Banket. Edward R. Schoch. An account of the theories advanced to explain these ore deposits in West Africa, with description of the gold occurrence. Also a short description of the Rhodesian conglomerate, and editorial. 3500 w. Eng & Min Jour—June 29, 1905. No. 70584.

Coeur d'Alene.

Ore Deposits of the Coeur d'Alene, Idaho. F. L. Ransome. Abstracted from Bul. 260 of the U. S. Geol. Survey. Describes the geology of this silver-lead region. 3000 w. Min & Sci Pr—July 8, 1905. Serial. 1st part. No. 70776.

The Coeur d'Alene District. F. L. Ransome. An illustrated article giving much information in regard to this lead-silver district in Idaho and Montana, which supplies more than one-third the lead mined in the United States. 2000 w. Min Mag—July, 1905. No. 70858 C.

Concentration.

Concentration of Silver-Lead Ores. V. F. S. Low. Abstract Trans. Aus. Min. Engrs. Applies to the concentration of the silver-lead ores of Broken Hill, N. S. W., especially to the ores in Block 10 mine. Ills. 3000 w. Min & Sci Pr—July 15, 1905. Serial. 1st part. No. 71007.

Cyaniding.

Cyanidation of Argentiferous Concentrate. Hugh G. Elwes. Gives tests aiming to show that by means of a preliminary chloridizing-roast rich silver ores, even when rebellious, can be successfully treated by cyanidation. 1800 w. Eng & Min Jour—July 2, 1905. No. 71015.

Cyaniding Silver-Gold Ores of the Palmarejo Mine, Chihuahua, Mexico. T. H. Oxnam. Describes the mines, the mill and cyanide plant, the old system of milling, and the experiments with wet-crushing, concentration and raw pan-amalgamation, the present system of milling and sands treatment, etc. Ills. 16500 w. Am Inst of Min Engrs—July, 1905. No. 71099 D.

Estimation of the Chief Constituents in Cyanide Solution. J. E. Clennell. Describes a method which has been in successful use in testing the solutions obtained in the treatment of gold-and silver-bearing ore at the Redjang Lebong mine, Sumatra. 2500 w. Eng & Min Jour—June 29, 1905. No. 70583.

The Development and Present Status of Cyanidation in the United States. William H. Davis. Reviews the history and methods, discussing crushing methods, alkalinity, treatment of coarse sands and slimes, and of high-grade ores, precipitation, regeneration, etc. 6000 w. Elec Chem & Met Ind—July, 1905. No. 70668 C.

Ore Treatment.

Ore Milling at Kalgoorlie. Harry J. Brooke. Describes the successful treatment of these ores, giving table showing the cost of one month's milling on 3,484 tons treated. 1500 w. Eng & Min Jour—July 6, 1905. No. 70671.

San Juan.

San Juan Region and Some of Its Peculiar Mines. Arthur Lakes. Describes this interesting region, and its peculiar features, and the American Nettie mine. Ills. 2000 w. Min Wld—July 15, 1905. No. 70766.

Tonopah.

Tonopah Mining District. J. E. Spurr. An illustrated article giving an interesting description of this gold and silver mining district, and the geology of the region. Maps. 5000 w. Jour Fr Inst—July, 1905. No. 70841 D.

Utah.

The Newhouse Mine and Mill. Illustrated description of the properties in Beaver Co., Utah. 1000 w. Eng & Min Jour—July 15, 1905. No. 70754.

Yukon.

Mining in the Yukon. F. T. Congdon. Excerpt from a recent address sketching the evolution in mining methods since 1896. 3300 w. Can Min Rev—July, 1905. No. 71045 B.

IRON AND STEEL.

Blast Furnaces.

Experimental Studies of the Reactions in the Blast Furnace (Experimentelle Studien über die Vorgänge im Hochofen). Dr. F. Zimmermann. Describing studies in the analysis of gases drawn from various zones in the blast furnace, and conclusions therefrom. 2000 w. Stahl u Eisen—July 1, 1905. No. 70943 D.

Briquettes.

Iron Ore Briquettes for the Blast Furnace. Henry Louis. Reviews the history of ore briquetting, describing the operations, and stating the advantages, and explaining various methods. Ills. 4000 w. Cassier's Mag—July, 1905. No. 71030 B.

Dry-Air Blast.

The Application of Dry-Air Blast to the Manufacture of Iron. Joseph W. Richards. A discussion of the paper by Mr. Gayley presented at the Lake Superior meeting. 3700 w. Am Inst of Min Engrs—July, 1905. No. 71095.

The Application of Dry-Air Blast to the Manufacture of Iron. T. W. Robinson. Discussion of paper by Mr. Gayley presented at the Lake Superior meeting and also at the New York meeting of the Iron and Steel Institute. 2500 w. Am Inst of Min Engrs—July, 1905. No. 91098.

Furnace Hoist.

Electrically-Driven Furnace Hoist (Elektrisch Betriebener Gichtaufzug). F. Collischonn. Illustrating and describing an inclined hoist, electrically driven, for automatically charging blast furnaces. 2000 w. Stahl u Eisen—June 15, 1905. No. 70940 D.

Gas Furnaces.

Progress in the Construction of Gas Furnaces for Use in Iron Works (Fortschritte im Bau von Gasöfen für Eisenhuttenwerke). A. Desgraz. A discussion of the application of gas-fired furnaces for reheating, and other metallurgical operations. Serial. Part I. 3000 w. Stahl u Eisen—July 1, 1905. No. 70942 D.

Grading.

Pig Iron Grading by Analysis. Hambden Buel. Abstract of a paper read before the Am. Soc. for Test Materials. Describes the method followed by the Central Iron & Coal Co., Holt, Ala. 1400 w. Ir Age—July 20, 1905. No. 70805.

Metallurgy.

Descriptive Metallurgy of Iron and Steel. Samuel Groves. The present number briefly reviews the progress of the stone age, bronze age, and iron age. Ills. 1400 w. Can Engr—July, 1905. Serial. 1st part. No. 70648.

Open Hearth.

Chemical Changes in the Open-Hearth Furnace. W. M. Carr. Gives diagrams showing the changes of composition occurring in a bath of molten metal treated under the open-hearth process when producing steel to enter into ordinary castings, with explanatory notes. 700 w. Ir & Steel Mag—July, 1905. No. 71087 D.

New Open-Hearth Steel Processes. P. Ackers. Read before the Min. & Met. Cong. at Liége. Considers the progress made by the open-hearth process, discussing recent improvements, especially the charging open-hearth furnaces with liquid pig-iron. 2200 w. Ir & Coal Trds Rev—July 11, 1905. No. 71000 A.

The Open-Hearth Process of Making Steel from Cast Iron (Die Herdofenstahlerzeugung aus Flüssigem Roheisen). Oskar Simmersbach. A review of the development of the open-hearth process, and its modifications and the extent to which it is superseding the Bessemer process. Two articles, 4000 w. Stahl u Eisen—June 15, July 1, 1905. No. 70939 each D.

Wrought-Iron.

The Manufacture and Characteristics of Wrought-Iron. James P. Roe. Briefly outlines the history of the manufacture of wrought iron, and discusses mechanical puddling, reactions of the puddled process, the structure of puddled iron, resistance to oxidation, defects of wrought-iron, and the conditions essential to successful puddling. 4500 w. Am Inst of Min Engrs—July, 1905. No. 71097.

MINING.

Bag-Houses.

Bag-Houses for Saving Fume. Reviews briefly the practice of filtration through cloth, and the applications, giving a description of a standard bag-house, and its operation. Ills. 1200 w. Eng & Min Jour—July 15, 1905. No. 70753.

Results of Bag-House Experiment in Connection with Tavener's Process. H. Rusdett. Gives drawing showing the manner in which the bag-house was constructed, and experiments proving that practically no gold is carried over from the test furnace, anl very little from the pan furnace, if the charging is carefully done. 1200 w. Jour Chem, Met & Min Soc of S Africa—May, 1905. No. 70871 E.

Boreholes.

Electrical Devices for Deep Borehole Surveying. Hugh F. Marriott. Read before the Inst. of Min. & Met. Describes in detail the construction of two sets of instruments for use in deep level borehole surveying, and gives results obtained. 5000 w. Eng News—July 27, 1905. No. 71066.

Cables.

The Influence of Bending Torsion, and Shocks upon Wire Cables (Einige Beiträge zu Biegungs, Torsions und Stossversuchen mit Seildrähten). Julius Divis. Data and results of experiments upon a variety of wire ropes adapted for mine hoists. Three articles. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 17, 24, July 1, 1905. No. 70949 each D.

Compressed Air.

See Mechanical Engineering, Power and Transmission.

Concentration.

The Callow Settling Tank. W. S. Zehring. Illustrates and describes this tank for settling the dilute overflows found in every concentrating mill. 1500 w. Min Wld—July 15, 1905. No. 70767.

Dredging.

Dredging—I. Prospecting and Historical. J. P. Hutchins. Reviews the history of dredge mining as introductory to a discussion of present practice. 1500 w. Eng & Min Jour—July 15, 1905. Serial. 1st part. No. 70751.

Faults.

Faults with Special Reference to Coal and Metal Mining. A. Lakes. An illustrated article explaining where faults are most likely to occur, and the indications of their presence. 1400 w. Min Rept—July 6, 1905. Serial. 1st part. No. 70678.

Haulage.

Tests with Haulage System to Economize Air. Translation from an article in *Gluckauf*, by Fr. Hempel. Gives practical results from trial tests with an endless-rope haulage driven by duplex air cylinders. Ills. 1200 w. Mines & Min—July, 1905. No. 70689 C.

Hydraulic Mining.

Notes on Hydraulic Mining Practice. Richard L. Grider. Abstract of an article in the Colorado School of Mines "Bulletin," Jan., 1905. Illustrated description of methods of work in a hydraulic mine. 3500 w. Eng News—July 20, 1905. No. 70831.

Lead Smelting.

Lead Smelting in the Scotch Hearth. Kenneth W. M. Middleton. Describes the present method as practiced in the North of England. 2300 w. Eng & Min Jour—July 6, 1905. No. 70674.

Machine Drill.

The Machine Drill in Mining. Reviews the progress made with the machine drill, the work it has accomplished, and the methods. Also its importance in economical working. Ills. 3500 w. Min & Sci Pr—July 15, 1905. No. 71006.

Mexico.

The Minerals of Maguarichic. Rufus M. Baggs, jr. Points out some interesting crystallizations observed in specimens from this camp in Mexico. Ills. 1100 w. Eng & Min Jour—July 6, 1905. No. 70670.

Mine Signals.

Electric Mine Signals and Telephones. George E. Walsh. Brief review of what has been accomplished in Europe and America. 1200 w. Min & Sci Pr—July 8, 1905. No. 70778.

Mine Surveying.

Mine Surveying as Carried on at Centre Star Mine, Rossland, B. C. L. Heber Cole. Describes the methods employed by the engineering staff of the War Eagle and Centre Star Mining Companies. Ills. 4000 w. Can Min Rev—July, 1905. No. 71044 B.

Mining Investments.

See Industrial Economy.

Mining Plant.

The Electrification of Mexican Mines. George E. Walsh. Information concerning important electric plants recently established for mining purposes, usually combining transportation, lighting and mine operation. 1500 w. Eng & Min Jour—July 6, 1905. No. 70673.

The New Shaft Equipment and Washing Plant of the Bethune Mining Company (Bemerkungen über die Neueste Schachtanlage 10 und die Zentralwäsche der Bergwerksgesellschaft Bethune). Describing one of the latest coal mining plants in Northern France, with plate showing general arrangement. 2500 w. 1 plate. Gluckauf—June 30, 1905. No. 70947 D.

The Plant at the Zollern Shaft No. II of the Gelsenkirchen Mining Company (Die Schachtanlage Zollern II der Gelsenkirchener Bergwerks-Aktien-Gesellschaft). H. Kandelbrock. A very fully illustrated description of a fine modern colliery equipment, including power house, head works, winding engines, etc. 7500 w. 3 plates. Glückauf—June 24, 1905. No. 70945 D.

Newfoundland.

Mineral Development in Newfoundland. Review of the annual report, compiled by James P. Howley, on the mineral statistics of the Island. 1800 w. Can Min Rev—June, 1905. No. 70657 B.

Norway.

Mining in Norway. M. Alger. Gives mines of various minerals with an account of their productions. 2500 w. the locations, histories, and products of Mines & Min—July, 1905. No. 70684 C.

Ore Deposits.

Ore Deposits of the Sierra De Los Caballos. Charles R. Keyes. Describes these deposits in South Central New Mexico. The ores found are galena carrying a small amount of silver, chalcopyrite and bornite, and gold bearing ores. Coal is also found, and lime and iron. 1800 w. Eng & Min Jour—July 29, 1905. No. 71110.

Organic Remains in Ore Deposits. Arthur Lakes. Interesting descriptions of animal and vegetable remains found in various mines. 2000 w. Eng & Min Jour —June 29, 1905. No. 70582.

Prospecting.

Prospecting with Churn Drills. George C. McFarlane. Illustrates and describes two arrangements devised by the writer which have worked successfully, describing methods used. 1800 w. Eng & Min Jour—July 29, 1905. No. 71108.

Pyrite.

Pyrite Mining in Virginia. R. H. Painter. Describes deposits of pyrite carrying more or less copper, the methods of mining, preparation for market, etc. 1700 w. Eng & Min Jour—July 29, 1905. No. 71109.

Pyritic Smelting. Abstract of the presidential address of Robert C. Sticht, before the Aust. Inst. of Min. Engrs. Gives an outline of its history. 2500 w. Aust Min Stand—June 7, 1905. Serial, 1st part. No. 70702 B.

Respirator.

The Pneumatogen, a New System of Respiration (Pneumatogen, ein Neues System von Atmungsapparaten). Drs. M. Bamberger and F. Böck. Describing an apparatus for exploring gaseous mines, employing sodium peroxide for regenerating the air. 4500 w. Glückauf—June 24, 1905. No. 70946 D.

Roasting.

Temperature in Roasting Gold Ore. William E. Greenawalt. Suggestions helpful in getting the best results, reporting laboratory experiments. 1200 w. Eng & Min Jour—July 29, 1905. No. 71107.

Safety Catches.

Safety Catches for Mine Cages. E. Mackay Heriot. Points out the risks from the cable breaking while hoisting, and illustrates some of the methods adopted for safety. 2000 w. Eng & Min Jour—July 22, 1905. No. 71014.

Screens.

Standard Screens for Screen Analysis. Courtenay de Kalb. Describes a set of screens based upon an arithmetical progression of successive differences between the differences in diameters of openings in successive screens. 1000 w. Eng & Min Jour—July 29, 1905. No. 71111.

Shafts.

A Device for Preventing Freezing in Drawing Pits. Dr. Alfred Gradenwitz. Illustrated description of the use of warm air to prevent the formation of ice in mine shafts. 500 w. Min Rept—July 6, 1905. No. 70677.

Concrete Lining for Mine Shafts. F. R. Dravo. Briefly considers other materials that have been tried, and describes the work of lining a shaft with concrete. General discussion. 3300 w. Pro Engrs' Soc of W Penn—July, 1905. No. 71104 D.

Sketches.

The Use of Sketches in the Mining Field. Arthur Lakes. Shows the advantages of sketching illustrations to accompany a mining report. Ills. 1200 w. Min Wld—July 22, 1905. No. 71093.

South Africa.

South African Mining. Fred E. Norton. On the extent to which compressed air is used, describing the peculiar conditions and the type of compressors. 3200 w. Mines & Min—July, 1905. No. 70683 C.

Structure.

Origin of Orbicular and Concretionary Structure. William P. Blake. Gives views of various writers in regard to the origin, and the results of a study of the white volcanic Tufta of Tucson, Ariz. Ills. 1500 w. Am Inst of Min Engrs—July, 1905. No. 71093.

Tube Mill.

The Theory of the Tube Mill. H. A. White. Illustrates and describes models and discusses the best rate of driving tube mills. 6000 w. Jour Chem, Met & Min Soc of S. Africa—May, 1905. No. 70872 E.

Valuation.

On the Examination and Valuation of Mines. John E. Hardman. Read before the Canadian Soc. of Civ. Engrs. An account of approved practice, with special reference to the difficulties or advantages, which Canadian deposits present. 4800 w

Can Min Rev—June, 1905. Serial. 1st part. No. 70659 B.

Veins.

The Occurrence of Pebbles, Concretions and Conglomerate in Metalliferous Veins. Edward Halse. Discusses the four causes to which these occurrences are attributed. 6000 w. Ills. Am Inst of Min Engrs—July, 1905. No. 71096 C.

Vein Outcrops. Gives sketches of a number of characteristic outcrops, with a diversity of geological conditions. 1400 w. Min Sci Pr—July 22, 1905. No. 71049.

Ventilation.

Outlines of Mine Ventilation. William Clifford. Discusses the art of producing a safe atmosphere in the underground workings of a coal mine, describing the earliest practice and tracing the progress. Ills. 3500 w. Pro Engrs' Soc of W Penn—July, 1905. No. 71102 D.

Winding.

Electric Winding Machines. Prof. Paul Habets. Read before the Inst. of Mech. Engrs. Gives a dynamic investigation of electric winding for collieries. 6500 w. Engng—June 30, 1905. Serial. 1st part. No. 70726 A.

The Steam Consumption of a Winding Engine (Versuche uber den Dampf verbrauch einer Dampfördermaschine). A. Czermak. With indicator and load diagrams showing the irregular work, and the economy effected by the use of cut-off. 2500 w. Oesterr Zeitschr f Berg u Huttenwesen—June 24, 1905. No. 70950 D.

MISCELLANY.

Aluminothermics.

Aluminothermics. E. Stuetz. Summary of a lecture before the Civ. Engrs. Club of Cleveland. Describes a few instances of the use of burning aluminum for the production of high temperatures. Ills. 1000 w. Jour Assn of Engng Socs—May, 1905. No. 71090 C.

The Use of Thermit in a Railroad Shop. Jas. F. Webb. Read before the Am. Found. Assn. Gives the writer's experience in making repairs with thermit. Ills. 1200 w. Foundry—July, 1905. No. 70860.

Asbestos.

Arizona Asbestos Deposits. Joseph Hyde Pratt. Describes the location and development of these deposits, the occurrence, etc. 1300 w. Min Wld—July 8, 1905. No. 70662.

Canada.

"Rare Minerals" in Canada. A report of the movement with a view to search for and mine the rarer minerals, such as radium, white mica, tourmaline, garnet, beryl, and others. 1200 w. Can Min Rev—June, 1905. No. 70658 B.

Exposition.

The Liége Exposition (Lütticher Weltausstellung). A review of the Liége industrial exposition with especial reference to the mining and metallurgical exhibits. Serial, Part I. 1500 w. Stahl u Eisen—June 1, 1905. No. 70938 D.

Graphite.

The Graphite Industry. Joseph Hyde Pratt. States the many uses of graphite, its occurrence, deposits, localities developed, etc. 3500 w. Min Wld—July 22, 1905. No. 71004.

Metallurgy

Metallurgy at the Meeting of the German Bunsen Society. Brief reviews of papers and discussions dealing with the physical properties of metals and alloys, presented at the Karlsruhe meeting, June 2d and 3d, 1905. 2400 w. Engr, Lond—July 14, 1905. No. 70890 A.

Natural Gas.

Natural Gas Pumping Plant at Hundred, West Virginia. F. C. Weber. Illustrates and describes a plant by which gas from wells is transmitted a distance of ninety miles. 3200 w. Mines & Min—July, 1905. No. 70681 C.

Radium.

Pitchblende and Carnotite. Dr. J. Ohly. Information concerning the concentrates produced by these radio-active minerals, and the methods of treatment. 900 w. Min Rept—June 29, 1905. No. 70564.

Salt.

The Salt Deposits of Northeastern Ohio. J. A. Bownocker. An account of the discovery and report of the wells. Plate. 1500 w. Am Geol—June, 1905. No. 70797 D.

Sardinia.

The Lead and Zinc Mines of Monteponi. Charles Will Wright. An interesting illustrated description of these mines in Sardinia, their location, development, methods of mining, etc. 1800 w. Min Mag—July, 1905. No. 70850 C.

Soft-Lead.

Soft Lead Resources of the United States. H. Foster Bain. Map, showing the more important of the lead-producing districts, with information concerning the deposits. Ills. 2400 w. Min Mag—July 1, 1905. No. 70857 C.

Technical Chemistry.

Some American Contributions to Technical Chemistry. Marcus Benjamin. An address delivered before the Congress of Arts and Sciences, St. Louis. A review of the discoveries of American chemists, including many advances in metallurgy. 5700 w. Sci Am Sup—July 29, 1905. No. 71085.

Tin.

Tin Mining and Smelting at Santa Barbara, Guanajuato, Mexico. A. H. Bromly. Describes the unusual character of these deposits, the workings, etc., giving results. Ills. 2200 w. Am Inst of Min Engrs—July, 1905. No. 71092.

Tin Plate.

The Making of Tin Plate. Illustrates and describes the modern process of manufacture. 2500 w. Met Work—July 29, 1905. No. 71078.

Tungsten.

The Boulder County, Colorado, Tungsten Deposits. Kirby Thomas. Remarks on the demand for tungsten due to its use as an alloy for high-grade steels, and an account of these deposits. Map. 1400 w. Min Wld—July 8, 1905. No. 70660.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Car Recording.

A New Method of Car Recording. F. Lincoln Hutchins. Brief description of a method using a registering machine. 900 w. Ry Age—July 28, 1905. No. 71106.

Explosives.

Transportation of Explosives on the P. R. R. Extracts from a recent circular giving regulations for the transportation of the various classes of explosives. 900 w. R R Gaz—Vol. XXXIX. No. 2. No. 70772.

Fast Trains.

Fastest Trains in the World. Angus Sinclair. Remarks on the 18-hour trains between New York and Chicago, run by the New York Central and the Pennsylvania lines, with illustrations of engines and cars. 1000 w. Ry & Loc Engng—July, 1905. No. 70666 C.

The New York-Chicago Fast Trains. A record of the speed of the special trains run over the road in June, with remarks. 1300 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70555.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Intermediate Valves as Applied to Straight Line Brake Systems. H. G. Westbrook. Explains the functions this valve must perform, and gives an illustrated description of a new design. 900 w. Compressed Air—June, 1905. No. 70795.

Caboose.

Four-Wheeled Caboose for the Big Four. Description, with engravings showing their construction and arrangement. 1000 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70558.

Cars.

The Hart Convertible Ballasting and Freight Car, and the Work of Ballasting Track. Illustrates and describes this convertible dump car and its operation. 2200 w. Eng News—July 6, 1905. No. 70615.

Electrification.

Lancashire and Yorkshire Railway—Bullfield Widening: Bolton. Illustrated description of the improvements recently effected, especially the application of electricity. 2200 w. Elec Engr, Lond—July 14, 1905. No. 70881 A.

Exhibition.

Locomotives at the Liége Exhibition. C. R. King. Describes interesting locomotives being shown at this important exhibition. 3300 w. Ry Age—July 14, 1905. No. 70763.

The Liége Exhibition. The present article describes the locomotives shown. Ills. 3000 w. Engr, Lond—June 23, 1905. Serial. 1st part. No. 70642 A.

Locomotives.

A French Locomotive with Water-Tube Boiler. Information and sections of a locomotive put in service on the Algerian lines of the Paris, Lyons and Mediterranean Railway. 700 w. Mech Engr—July 1, 1905. No. 70708 A.

A Unique Locomotive for South Africa. F. C. Coleman. Illustration, with brief description of an unusual design for working heavy freight trains over the severe grades and sharp curves on the Rhodesia railway. 800 w. Sci Am—July 29, 1905. No. 71081.

Central Vermont Compound Consolidation. Illustrated detailed description of Compounds constructed on the Richmond system. 350 w. Ry Age—June 30, 1905. No. 70566.

Compound Articulated Locomotive for South America. Gives the first of a series of drawings of compound locomotives on the articulated system, built for the metre-gauge line of the Central Northern Railway of the Argentine Republic, with brief note. 150 w. Engng—July 14, 1905. Serial. 1st part. No. 70897 A.

Eight-Wheel Passenger Engine with Superheater, D. L. & W. R. R. Illustrations and descriptive data of an anthracite culm burner. 800 w. Ry Mas Mech—July, 1905. No. 70845.

Extended Piston Rods on Union Pacific Vauclain Compounds. G. H. Likert. States the difficulties experienced with the first design, and the remedy by the use of extended piston rods. 900 w. R R Gaz—Vol. XXXIX. No. 4. No. 71077.

Four-Cylinder Balanced Compound Passenger Locomotive, Pacific Type. Illustrated description of an important design for the Oregon R. R. & Nav. Co., in which the Vauclain 4-cylinder compound arrangement was applied to a six-coupled engine. 500 w. Am Engr & R R Jour—July, 1905. No. 70587 C.

Four-Cylinder Compound Locomotives on the Paris-Orleans Railway. Abstract of an article by M. P. Gone in *La Revue Générale*. Description, with results of tests, dynamometer records, etc. 1500 w. R R Gaz—Vol. XXXIX. No. 4. No. 71076.

Pacific Type Four-Cylinder Balanced Compound Locomotive. Illustrated description of an engine built for the Oregon Railroad & Navigation Co. 300 w. Ry Age —July 14, 1905. No. 70764.

Paris Ceinture Railway. Tandem Compound Locomotive. Illustrates and describes a type in use in France, with report of performance on suburban rapid service. 1200 w. Engr, Lond—July 7, 1905. No. 70793 A.

Powerful Switching Locomotives for the Lake Shore. Illustrated description of the largest and most powerful switching engines yet built, intended for pushing trains over the humps in gravity yards. 300 w. R R Gaz—Vol. XXXIX. No. 3. No. 70850.

Service of the Mallet Compound on the Baltimore and Ohio. Gives the average performance of this locomotive for 24 consecutive trips helping trains over the mountain districts, with information. 1000 w. Ry Age—July 7, 1905. No. 70650.

Six-Wheel (0-6-0) Switching Engine, Southern Railway. Brief illustrated description. 200 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70557.

The Development of Large Locomotives. Arthur M. Greene, Jr. An illustrated review of the development and growth of the large locomotive. 3500 w. Pro St Louis Ry Club—June 9, 1905. No. 70814.

Oscillations.

The Behavior of Locomotive Suspensions (Le Fonctionnement des Organes de la Suspension dans les Locomotives). A. Herdner. An examination of the influence of the method of suspension of a locomotive upon the magnitude and extent of its oscillations. Serial. Part I. 7500 w. Rev Gen des Chem de Fer—June, 1905. No. 71053 G.

Refrigerator Cars.

Development of Refrigerator Car Service on the Burlington. Reviews the history of their use and gives facts of interest in regard to the service, especially on the road named. 2500 w. Ry Age—June 30, 1905. No. 70565.

Staybolts.

Locomotive Water Space Stays. B. E. D. Stafford. A comparison of flexible and rigid stay bolts, illustrating types. Discussion. 6500 w. Pro Ry Club of Pittsburgh—April, 1905. No. 70813 C.

Superheaters.

Superheaters in Locomotives. J. B. Flamme. Read before the Inst. of Mech. Engrs. at Liege. Illustrated description of the arrangements for producing superheated steam in some engines on the Belgium State Railways and report of results. 2800 w. Engng—June 23, 1905. No. 70638 A.

Tender.

7,000-Gal. Tender of the Louisville & Nashville. Drawings of underframe, plan and sections of tank are given, with brief description. 600 w. R R Gaz—Vol. XXXIX. No. 2. No. 70769.

NEW PROJECTS.

Extension.

Extending the Santa Fe Railroad into San Francisco. Herbert I. Bennett. Illustrates and describes an interesting piece of railroad construction in California, where a swamp was crossed on an embankment of peat and decayed tule grass. 1200 w. Sci Am Sup—July 15, 1905. No. 70747.

South Africa.

The Central South African Railways. A review of the work accomplished and projected. 1500 w. Engr, Lond—July 7, 1905. No. 70792 A.

PERMANENT WAY AND BUILDINGS.

Locomotive Works.

A Large Locomotive Building and Repair Works in France. Charles R. King. A fully illustrated account of the shops of the Eastern Railway of France at Epernay. 4500 w. Engineering Magazine—August, 1905. No. 71085 B.

Maintenance.

Some Records of Maintenance-of-Way Expenses on American Railways. Replies to inquiries and information from individual railway companies, with editorial discussion. 6000 w. Eng News—July 27, 1905. No. 71063.

Rail Sections.

The New British Standard Rail Sections. Gives the principal parts of the specifications, with comments. 1500 w. Eng News—July 27, 1905. No. 71062.

Rails.

Some Causes of Failure of Rails in Service. Robert Job. From a paper read before the Am. Soc. for Testing Materials. Gives the causes brought out by extensive investigations of rail failures made by the Philadelphia & Reading Railway. Ills. 1800 w. R R Gaz—Vol. XXXIX. No. 1. No. 70675.

Signals.

A New System of Signalling on the Midland Railway. Illustrates and describes the new system of electric signalling installed at Derby station. 3800 w. Elect'n, Lond—June 23, 1905. No. 70635 A.

The Krupski System of Electric Distance Signals (Krupskis Stromlauf an ordnung für Elektrische Distanz signale). L. Kohlfürst. A detailed description of the automatic electric signal system used on the Swiss railways. 1800 w. Schweiz Bauzeitung. June 3, 1905. No. 70953 B.

Switzerland.

The Prolongation of the Appenzell Railway from Gais to Appenzell (Die Verlängerung der Appenzeller Strassenbahn von Gais nach Appenzell). L. Kürsteiner. With profile and topographical map of the route and details of the combined adhesion and rack locomotives. 1800 w. Schweiz Bauzeitung—June 17, 1905. No. 70955 B.

Terminals.

Recent Terminal Improvements in St. Louis. Daniel Breck. Gives a general view of the problems as they presented themselves and the methods employed in defining difficulties and reaching solutions. 9 plates. 5500 w. Jour Assn of Engng Socs—May, 1905. No. 71088 C.

Some Details of Reconstruction Work, St. Louis Union Station. A P. Greensfelder. Describes the work at the St. Louis station and vicinity which was under the direct charge of the writer, giving reasons for the adoption of the various plans and methods. 10,000 w. Jour Assn of Engng Socs—May, 1905. No. 71089 C.

The Baltimore Terminal of the Western Maryland R. R. Illustrated description of the Atlantic terminus of the Gould railroad system. 2500 w. Eng Rec—July 1, 1905. No. 70598.

Ties.

Creosoting Works of the Western Railway of France. Extracts from an article by J. M. Merklen, in *Revue Generale des Chemins de Fer,* giving particulars of the plant at Surdon, France. 1200 w. Eng News—July 27, 1905. No. 71064.

TRAFFIC.

Clearing System.

Further Observations Regarding the Railway Clearing House of England. J. W. Midgley. Considers the difficulties due to freight classification, and discusses the "coaching" department in England, the mileage department, and other English methods. 5000 w. Ry Age—July 7, 1905. Serial. 1st part. No. 70651.

Industrial Departments.

Industrial Departments of Railways. Discusses methods of modern management to provide for future traffic and increase the revenue. 2500 w. Ry Age—July 14, 1905. No. 70765.

Interline Accounts.

Method of Settling Interline Accounts. A paper prepared under instructions from the Assn. of Am. Ry Acc. Officers, explaining the manner of settling interline accounts between railroads in the United States, Canada and Mexico. 1500 w. Ry Age—July 14, 1905. No. 70762.

Rates.

English Railway Rate Making and Governmental Rate Control. Abstracts from a recent work by W. M. Acworth, with comments by W. D. Taylor. 4500 w. Ry Age—July 21, 1905. No. 71009.

MISCELLANY.

Estimates.

Estimates for Railways for Light Traffic. William D. Marks. Gives detailed estimates of such railways, discussing a recent paper by Jas. Cravath. 2200 w. Eng News—July 20, 1905. No. 70829.

France.

Financial Results of the French Railroads in 1903. Statement of the results of operation, with comparison with 1902, and review of the accounts in general. 2400 w. R R Gaz—Vol. XXXVIII. No. 26. No. 70556.

Legislation.

Connecticut's New Railroad Legislation. Clarence Deming. A review of what was accomplished in the legislative session of 1905, especially as affecting the New Haven Company. 2000 w. R R Gaz—Vol. XXXIX. No. 3. No. 70851.

STREET AND ELECTRIC RAILWAYS

Car Designs.

Car Designs and Carrying Capacity. John P. Fox. A second article, discussing doors, vestibules, etc. Illustrated. 2700 w. St Ry Jour—July 1, 1905. No. 70575 C.

Cars.

Suitable Cars for City and Suburban Service. T. W. Wilson, Read before the St. Ry. Assn. of the State of N. Y. Discusses the size and arrangement of cars for interurban and for city service. 2200 w. St Ry Jour—July 8, 1905. No. 70656 C.

Types of Interurban Cars. J. N. Shannahan. Read before the St. Ry. Assn. of the State of N. Y. Describes two types of cars used on the Fonda, Johnstown & Gloversville R. R., pointing out the advantages and disadvantages of the service. 1500 w. St Ry Jour—July 1, 1905. No. 70579 C.

Germany.

Electric Traction Systems of the Future (Die Elektrischen Bahnsysteme der Gegenwart). F. Niethammer. A general examination of the various systems in use and proposed for tramway and railway service. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—July 1, 1905. No. 70911 D.

The Proposed Blankenese-Ohlsdorf Electric Railway (Ueber den Geplanten Elektrischen Betrieb der Hamburger Stadtbahn Blankenese-Ohlsdorf). Gustav Schimpff. With map and profiles of the extension of the Hamburg electric railway system to neighboring towns using single phase traction. 3500 w. Elektrotech Zeitschr—June 22, 1905. No. 70976 B.

The Future Development of Electric Railways in Germany (Die Zukünftige Entwickelung der Elektrischen Bahnen in Deutschland). Dr. R. Haas. A. Review of electric traction in Germany, and its influence upon main-line projects. 5000 w. Elektrotech Zeitschr—June 29, 1905. No. 70978 B.

Interurban.

Permanent Way and Structures of the Toledo Urban and Interurban Railway. John S. Worley. Describes the construction of this road as an example of high grade work. Ills. 2800 w. Eng News—July 13, 1905. No. 70743.

The San Jose and Los Gatos Interurban Railway Company. Illustrates and describes this system, which is distinctively a passenger road, though considerable freight is hauled. 2500 w. Jour of Elec—July, 1905. No. 71037 C.

Instruction Car.

New Instruction Car for the Brooklyn Rapid Transit Company. Illustrated detailed description of the car and its equipment. 2400 w. St Ry Jour—July 29, 1905. No. 71050 C.

Manila.

Electric Railroad and Light System of Manila. An illustrated article giving information of the stations, and their equipment, power house, etc. 4500 w. Far East Rev—May, 1905. No. 70803 D.

Motor Connections.

Mistakes in Motor Connections and Their Effects. Cale Gough. Gives a diagram showing all the misconnections possible of the No. 1 motor leads, with the effects produced, with explanatory notes. 1000 w. St Ry Jour—July 8, 1905. No. 70654 C.

Mountain Railway.

A French Mountain Railway. Brief illustrated description of the electric mountain railway operating between Chamonix and Fayet, in the Mont Blanc region. 700 w. Ry Age—July 21, 1905. No. 71010.

New Electric Cars for Adhesion and Rack Driving on the Stansstad-Engelberg Railway (Neuer Elektrischer Automobilwagen für Adhäsions und Zahnstangenbetrieb der Stansstad Engelbergbahn). W. Burkard. With diagrams and photographs of the trucks, showing arrangement of motors and gearing. 2500 w. Schweiz Bauzeitung—May 20, 1905. No. 70951 B.

Portable Sub-Station.

Portable Sub-Station for Cincinnati & Columbus Traction Company. John R. Hewett. Illustrated description of this car and the apparatus installed. 1500 w. St Ry Jour—July 8, 1905. No. 70653 C.

Power Station.

A Large Power Station Operated with Fuel Oil. W. D. Chamberlain. Illustrated detailed description of the North Beach power station of the United Railroads of San Francisco, and its equipment and operation. 6800 w. Power—Aug., 1905. No. 71033 C.

Brunots Island Power Station of the Pittsburg Railways Co. Illustrated detailed description of the station and its equipment. 1600 w. St Ry Rev—July 15, 1905. No. 70845 C.

New Power Station of the Saginaw and Bay City Railway and Light Company. Illustrated detailed description. 3300 w. Engr, U S A—July 15, 1905. No. 70757 C.

Power House for the New York Central Electric Lines. An illustrated description of the generating station under construction at Utica, N. Y., from which power will be distributed east and west along the lines of electric railway that parallel the New York Central R. R. 1800 w. Elec Wld & Engr—July 15, 1905. No. 70758.

See also Electrical Engineering, Generating Stations.

Rapid Transit.

Rapid Transit in Great Cities. William Barclay Parsons. From an address delivered at Purdue University. An interesting article dealing mainly with underground railways, their engineering and legal aspects, and various phases of the problem. 6000 w. R R Gaz—Vol. XXXIX. No. 3. No. 70849.

Regulator.

Single-Phase Induction Regulator. B. G. Bergman. Describes the design and explains the operation. The field for the induction regulator is apparently limited to heavy locomotives for freight service. 2000 w. Elec Wld & Engr—July 8, 1905. No. 70691.

Road Traction.

Trackless Electric Traction (Gleislose Elektrische Bahnen). Max Schiemann. A review of the recent progress in the use of the overhead electric trolley system for use on common roads. 3000 w. Elektrotech Zeitschr—July 6, 1905. No. 70981 B.

Scotland.

The Paisley and District Tramway System. An illustrated account of this undertaking, with map. 3500 w. Tram & Ry Wld—July 13, 1905. No. 70846 B.

Shops.

New Car Shops and Houses for the Public Service Corporation of New Jersey. Martin Schreiber. Gives plans and description of one of the most complete and modern railways shop and car-house plants in the country, soon to be erected at Newark, N. J. 6500 w. St Ry Jour—July 22, 1905. No. 71012 C.

Single Phase.

The Single-Phase Railway System, Its Field and Its Development. Charles F. Scott. Reviews briefly the status of electric railway engineering just prior to the announcement of the single-phase railway motor, and the engineering evolution of the system since that time. 2200 w. Elec Jour—July, 1905. No. 70808.

Single-Phase.

The Development of the Single-Phase Railway System. Gives a table of lines using or proposing to use the Westinghouse system of single-phase railway traction, and describes the apparatus employed and the general manner of operating the Indianapolis and Cincinnati Railway. Ills. 2000 w. Engng—July 28, 1905. No. 71251 A.

Sub-Station.

The Fisher Street Street Sub-Station of the Metropolitan Electric Supply Co., Ltd. Illustrated detailed description, especially of switch gear. 2400 w. Elec Rev, Lond—July 28, 1905. No. 71250 A.

Swansea.

Swansea Electricity Undertaking and Tramway Department. C. A. L. Prusmann. Briefly describes the pump-room, boiler-house, economizer shed, engine-room, battery-room, feeders and distributing mains, equipment, &c. Ills. 3000 w. Elec Engr, Lond—July 28, 1905. No. 71249 A.

Sunderland.

Sunderland District Tramways. Illustrated description of a system serving a moderately populated district. 2200 w. Tram & Ry Wld—July 13, 1905. No. 70847 B.

Terminal.

The New Manhattan Terminal for the Brooklyn Bridge. Illustrations and description of the principal features of the proposed new station, and the arrangement of tracks. 600 w. R R Gaz—Vol. XXXIX. No. 2. No. 70771.

Traction Work.

The Electrical Engineer in Heavy Traction Work. William McClellan. A discussion of the special problems and methods developed in this line of work. Ills. 11400 w. Pro Engrs' Club of Phila—July, 1905. No. 70867 D.

Trolleys.

Trolley Standards: Their Liability to Become Dangerous to the Public, and Some Devices for Rendering Them Safe. P. J. Pringle. Refers especially to dangers on double-deck cars, giving an illustrated description of a device for promoting safety. 2200 w. Elec Engr, Lond—July 14, 1905. No. 70882 A.

Variable Load.

The Relation of Variable Load to Cost of Transmission in Electric Railway Problems. Sydney W. Ashe. Shows how the line loss may be found from the load diagram, giving examples. 600 w. Eng News—July 13, 1905. No. 70741.

Wheels.

The Wheel Question. C. G. Bacon, Jr. Gives results of recent investigations of wheels and conclusions drawn, discussing certain points. 2000 w. St Ry Jour—July 8, 1905. No. 70655 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C
Builder. *w.* London.
Bull. Am. Iron and Steel Assn. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

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